Department of Mechanical Engineering
Course Outcomes R-2019 University of Mumbai Syllabus
(C Scheme)
Second Year (3rd Semester)
Subject: Engineering Mathematics-III (MEC301)

CO1.   Apply the concept of Laplace transform to solve the real integrals in engineering problems.

CO2.   Apply the concept of inverse Laplace transform of various functions in engineering problems.

CO3.   Expand the periodic function by using Fourier series for real life problems and complex engineering problems.

CO4.   Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.

CO5.   Apply Matrix algebra to solve the engineering problems.

CO6.   Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Subject: Strength of Materials (MEC302)

CO1.   Demonstrate fundamental knowledge about various types of loading and stresses induced.

CO2.   Draw the SFD and BMD for different types of loads and support conditions.

CO3.   Analyse the bending and shear stresses induced in beam.

CO4.   Analyse the deflection in beams and stresses in shaft.

CO5.   Analyse the stresses and deflection in beams and Estimate the strain energy in mechanical elements.

CO6.   Analyse buckling phenomenon in columns.

Subject: Production Processes (MEC303)

CO1.   Demonstrate an understanding of casting process

CO2.   Illustrate principles of forming processes.

CO3.   Demonstrate applications of various types of welding processes.

CO4.   Differentiate chip forming processes such as turning, milling, drilling, etc.

CO5.   Illustrate the concept of producing polymer components and ceramic components.

CO6.   Illustrate principles and working of non-traditional manufacturing

CO7.   Understand the manufacturing technologies enabling Industry 4.0

Subject: Materials and Metallurgy (MEC304)

CO1.   Identify the various classes of materials and comprehend their properties

CO2.   Apply phase diagram concepts to engineering applications

CO3.   Apply particular heat treatment for required property development

CO4.   Identify the probable mode of failure in materials and suggest measures to prevent them

CO5.   Choose or develop new materials for better performance

CO6.   Decide an appropriate method to evaluate different components in service

Subject: Thermodynamics (MEC305)

CO1.   Demonstrate application of the laws of thermodynamics to a wide range of systems.
CO2.   Compute heat and work interactions in thermodynamic systems
CO3.   Demonstrate the interrelations between thermodynamic functions to solve practical problems.
CO4.   Compute thermodynamic interactions using the steam table and Mollier chart
CO5.   Compute efficiencies of heat engines, power cycles.
CO6.   Apply the fundamentals of compressible fluid flow to the relevant systems

Subject: Materials Testing (MEL301)

CO1.   Prepare metallic samples for studying its microstructure following the appropriate procedure.
CO2.   Identify effects of heat treatment on microstructure of medium carbon steel and hardenability of steel using Jominy end Quench test
CO3.   Perform Fatigue Test and draw S-N curve
CO4.   Perform Tension test to Analyze the stress - strain behaviour of materials
CO5.   Measure torsional strength, hardness and impact resistance of the material
CO6.   Perform flexural test with central and three point loading conditions

Subject: Machine Shop Practice (MEL302)

CO1.   Know the specifications, controls and safety measures related to machines and machining operations.
CO2.   Use the machines for making various engineering jobs.
CO3.   Perform various machining operations
CO4.   Perform Tool Grinding
CO5.   Perform welding operations

Subject: Skill Based Lab: CAD – Modeling (MESBL303)

CO1.   Illustrate basic understanding of types of CAD model creation.
CO2.   Visualize and prepare 2D modeling of a given object using modelling software.
CO3.   Build a solid model of a given object using 3D modeling software.
CO4.   Visualize and develop the surface model of a given object using modelling software.
CO5.   Generate assembly models of given objects using assembly tools of a modelling software
CO6.   Perform product data exchange among CAD systems.

Subject: Mini Project - 1A (MEPBL301)

CO1.   Identify problems based on societal /research needs.
CO2.   Apply Knowledge and skill to solve societal problems in a group.
CO3.   Develop interpersonal skills to work as a member of a group or leader.
CO4.   Draw the proper inferences from available results through theoretical/ experimental/simulations.
CO5.   Analyse the impact of solutions in societal and environmental context for sustainable
CO6.   development.

CO7.   Use standard norms of engineering practices
CO8.   Excel in written and oral communication.
CO9.   Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
CO10.   Demonstrate project management principles during project work.

Second Year (4th Semester)
Subject: Engineering Mathematics-IV (MEC401)

CO1.   Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.

CO2.   Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.

CO3.   Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.

CO4.   Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.

CO5.   Apply the concept of probability distribution to engineering problems & Testing hypothesis of small samples using sampling theory

CO6.   Apply the concepts of parametric and nonparametric tests for analysing practical problems.

Subject: Fluid Mechanics (MEC402)

CO1.   Define properties of fluids, classify fluids and evaluate hydrostatic forces on various surfaces.

CO2.   Illustrate understanding of dimensional analysis of Thermal and Fluid systems.

CO3.   Differentiate velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.

CO4.   Formulate and solve equations of the control volume for fluid flow systems and Apply Bernoulli's equation to various flow measuring devices.

CO5.   Calculate pressure drop in laminar and turbulent flow, evaluate major and minor losses in pipes.

CO6.   Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces.

Subject: Kinematics of Machinery (MEC403)

CO1.   Identify various components of mechanisms

CO2.   Develop mechanisms to provide specific motion

CO3.   Draw velocity and acceleration diagrams of various mechanisms

CO4.   Choose a cam profile for the specific follower motion

CO5.   Predict condition for maximum power transmission in the case of a belt drive

CO6.   Illustrate requirements for an interference-free gear pair

Subject: CAD/CAM (MEC404)

CO1.   Identify suitable computer graphics techniques for 3D modelling.

CO2.   Transform, manipulate objects & store and manage data.

CO3.   Develop a 3D model using various types of available biomedical data.

CO4.   Create the CAM Toolpath for specific given operations.

CO5.   Build and create data for 3D printing of any given object using rapid prototyping and

tooling processes.

CO6.   Illustrate understanding of various cost effective alternatives for manufacturing products.

Subject: Industrial Electronics(MEC405)

CO1.   Illustrate construction, working principles and applications of power electronic switches.
CO2.   Identify rectifiers and inverters for dc and ac motor speed control.
CO3.   Develop circuits using OPAMP and Timer IC 555.
CO4.   Identify digital circuits for industrial applications.
CO5.   Demonstrate the knowledge of basic functioning of microcontrollers.
CO6.   Analyze speed-torque characteristics of electrical machines for speed control.

Subject: Industrial Electronics (MEL401)

CO1.   Demonstrate characteristics of various electrical and electronics components
CO2.   Develop simple applications built around these components
CO3.   Identify use of different logic gates and their industrial applications
CO4.   Built and demonstrate parameter measurements using microcontroller
CO5.   Test and Analyze speed-torque characteristics of electrical machines for speed control.

Subject: Kinematics of Machinery (MEL402)

CO1.   Draw velocity diagram using Instantaneous Centre method
CO2.   Find velocity and acceleration of a point on a four-bar mechanism by using
CO3.   Relative method.
CO4.   Analyse velocity and acceleration of a specific link of a slider crank mechanism using graphical approach by Relative method.
CO5.   Plot displacement-time, velocity-time, and acceleration-time diagrams of follower motion.
CO6.   Draw cam profile for the specific follower motion.
CO7.   Develop and build mechanisms to provide specific motion.

Subject: Python Programming (MEL403)

CO1.   Demonstrate understand of basic concepts of python programming.
CO2.   Identify, install and utilize python packages
CO3.   Develop and execute python programs for specific applications.
CO4.   Develop and build python program to solve real-world engineering problems
CO5.   Prepare a report on case studies selected.

Subject: Skill based Lab: CNC and 3-D Printing (MESBL401)

CO1.   Develop and execute part programing for any given specific operation.
CO2.   Build any given object using various CNC operations.
CO3.   Demonstrate CAM Tool path and prepare NC- G code.
CO4.   Develop 3D model using available biomedical data
CO5.   Build any given real life object using the 3D printing process.

Vishwaniketan's

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CO6.   Convert 2D images into 3D model

Subject: Mini Project - 1B (MEPBL401)

CO1.   Identify problems based on societal /research needs.
CO2.   Apply Knowledge and skill to solve societal problems in a group.
CO3.   Develop interpersonal skills to work as member of a group or leader.
CO4.   Draw the proper inferences from available results through theoretical/
CO5.   experimental/simulations.
CO6.   Analyse the impact of solutions in societal and environmental context for sustainable development.
CO7.   Use standard norms of engineering practices
CO8.   Excel in written and oral communication.
CO9.   Demonstrate capabilities of self-learning in a group, which leads to life long learning.
CO10.   Demonstrate project management principles during project work.

Course Outcomes R2019 University of Mumbai Syllabus
(C Scheme)
Third Year (5th Semester)
Subject: Mechanical Measurements and Controls (MEC501)

CO1.   Handle, operate and apply the precision measuring instruments / equipments.
CO2.   Analyze simple machined components for dimensional stability & functionality.
CO3.   Classify various types of static characteristics and types of errors occurring in the system.
CO4.   Classify and select proper measuring instruments for displacement, pressure, flow and temperature measurements.
CO5.   Design mathematical model of system/process for standard input responses and analyse error and differentiate various types of control systems and time domain specifications
CO6.   Analyse the problems associated with stability.

Subject: Thermal Engineering (MEC502)

CO1.   Analyze the three modes of heat transfer in engineering application.
CO2.   Develop mathematical models for different modes of heat transfer.
CO3.   Analyze performance parameters of different types of heat exchangers.
CO4.   Identify and analyze the Transient heat Transfer in engineering applications.
CO5.   Explain construction and working of different components of internal combustion engines.
CO6.   Evaluate engine performance and emission characteristics.

Subject: Dynamics of Machinery (MEC503)

CO1.   Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems
CO2.   Illustrate basic of static and dynamic forces
CO3.   Determine natural frequency of element/system
CO4.   Determine vibration response of mechanical elements / systems
CO5.   Design vibration isolation system for a specific application
CO6.   Demonstrate basic concepts of balancing of forces and couples

Subject: Finite Element Analysis (MEC504)

CO1.   Solve differential equations using weighted residual methods.
CO2.   Develop the finite element equations to model engineering problems governed by second order differential equations.
CO3.   Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional element.
CO4.   Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements.
CO5.   Apply the basic finite element formulation techniques to find natural frequency of a single degree of vibration system.
CO6.   Use commercial FEA software, to solve problems related to mechanical engineering.

Subject: Optimization Techniques (MEDLO5011)

CO1.   Identify the types of optimization problems and apply the calculus method to single variable problems.

CO2.   Formulate the problem as Linear Programming problem and analyse the sensitivity of a decision variable.

CO3.   Apply various linear and non-linear techniques for problem solving in various domains.

CO4.   Apply multi-objective decision making methods for problem in the manufacturing environment and other domain.

CO5.   Apply multi criterion decision making methods for problem in manufacturing environment and other domain.

CO6.   Apply Design of Experiments method for Optimization

Subject: Design of Experiments (MEDLO5012)

CO1.   Plan, design, and conduct experimental investigations efficiently and effectively;

CO2.   Understand strategy in planning and conducting experiments;

CO3.   Choose an appropriate experimentation scheme to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.

Subject: Computational Methods (MEDLO5013)

CO1.   Understand and develop mathematical models of physical systems.

CO2.   Identify an appropriate mathematical formulation to linear algebraic equations.

CO3.   Build an appropriate mathematical formulation to non-linear algebraic equations.

CO4.   Evaluate and interpret the data regression, curve fitting and statistics.

CO5.   Apply the numerical techniques and numerical schemes.

CO6.   Formulate the concept of numerical methods in realistic applications.

Subject: Thermal Engineering (MEL501)

CO1.   Estimate thermal conductivity of engineering materials.

CO2.   Evaluate performance parameters of extended surfaces.

CO3.   Analyse heat transfer parameters in various engineering applications.

CO4.   Analyze engine performance and emission parameters at different operating conditions.

Subject: Dynamics of Machinery (MEL502)

CO1.   Plot and analyze governor characteristics

CO2.   Analyze gyroscopic effect on laboratory model

CO3.   Estimate natural frequency of mechanical systems

CO4.   Analyze vibration response of mechanical systems

CO5.   Determine damping coefficient of a system

CO6.   Balance rotating mass

Subject: Finite Element Analysis (MEL503)

CO1.   Select appropriate element for given problem

CO2.   Select suitable meshing and perform convergence test

CO3.   Select appropriate solver for given problem

CO4.   Interpret the result

CO5.   Apply basic aspects of FEA to solve engineering problems

CO6.   Validate FEA solution

Subject: Professional Communication And Ethics - II (MESBL501)

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CO1.   Plan and prepare effective business/ technical documents which will in turn provide a solid foundation for their future managerial roles.

CO2.   Strategize their personal and professional skills to build a professional image and meet the demands of the industry.

CO3.   Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.

CO4.   Deliver persuasive and professional presentations.

CO5.   Develop creative thinking and interpersonal skills required for effective professional communication.

CO6.   Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Third Year (6th Semester)
Subject: Machine Design (MEC601)

CO1.   Use design data book/standard codes to standardise the designed dimensions
CO2.   Design Knuckle Joint, cotter joint and Screw Jack
CO3.   Design shaft under various conditions and couplings
CO4.   Select bearings for a given applications from the manufacturers catalogue.
CO5.   Select and/or design belts and flywheel for given applications
CO6.   Design springs, clutches and brakes

Subject: Turbo Machinery (MEC602)

CO1.   Define various parameters associated with steam generators and turbo machines.
CO2.   Identify various components and mountings of steam generators with their significance.
CO3.   Identify various turbo machines and explain their significance.
CO4.   Apply principles of thermodynamics and fluid mechanics to estimate various parameters like mass flow rate power, torque, efficiency, temperature, etc.
CO5.   Evaluate performance of SG and Turbo machines and apply various techniques to enhance performance.
CO6.   Evaluate various phenomena related to performance like cavitation, choking, surging.

Subject: Heating,Ventilation,Air Conditioning and Refrigeration (MEC603)

CO1.   Illustrate the fundamental principles and applications of refrigeration and air conditioning
CO2.   systems.
CO3.   Identify various HVAC&R components
CO4.   Evaluate performance of various refrigeration system
CO5.   Estimated cooling and heating loads for an air conditioning system.
CO6.   Select air handling unit & design air distribution system
CO7.   Apply the knowledge of HVAC for the sustainable development of refrigeration and air conditioning systems.

Subject: Automation and Artificial Intelligence (MEC604)

CO1.   Demonstrate understanding of fundamentals of industrial automation and AI.
CO2.   Design & develop pneumatic / hydraulic circuits.
CO3.   Design and develop electro pneumatic circuits and PLC ladder logics.
CO4.   Demonstrate understanding of robotic control systems and their applications.
CO5.   Demonstrate understanding of various AI and machine learning technologies.

Subject: Press Tool Design (MEDLO6021)

CO1.   Demonstrate various press working operations for mass production of sheet metal parts
CO2.   Identify press tool requirements to build concepts pertaining to design of press tools
CO3.   Prepare working drawings and setup for economic production of sheet metal components
CO4.   Select suitable materials for different elements of press tools
CO5.   Illustrate the principles and blank development in bent & drawn components
CO6.   understand safety aspects and automation in press working

Subject: Tool Engineering (MEDLO6022)

CO1. Calculate the values of various forces involved in the machining operations
CO2. Design various single and multipoint cutting tools
CO3. Analyze heat generation in machining operation and coolant operations
CO4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
CO5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
CO6. Analyze economics of machining operations

Subject: Metal FormingTechnology (MEDLO6023)

CO1. Understand the concept of different metal forming process.
CO2. Approach metal forming processes both analytically and numerically
CO3. Design metal forming processes
CO4. Develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.

Subject: Machine Design (MEL601)

CO1. Design shaft under various conditions
CO2. Design Knuckle Joint / cotter joint
CO3. Design Screw Jack
CO4. Design Flexible flange couplings/ Leaf spring
CO5. Convert design dimensions into working/manufacturing drawing
CO6. Use design data book/standard codes to standardise the designed dimensions.

Subject: Turbo Machinery (MEL602)

CO1. Differentiate boiler, boiler mountings and accessories
CO2. Conduct a trial on reciprocating compressor / centrifugal compressor.
CO3. Conduct a trial on impulse turbine and analyze its performance
CO4. Conduct a trail on reaction turbine and analyze its performance
CO5. Conduct a trial on Centrifugal pump and analyze its performance
CO6. Conduct a trial on Reciprocating pump and analyze its performance
CO7. Conduct a trial on gear pump

Subject: Heating, Ventilation, Air Conditioning and Refrigeration (MEL603)

CO1. Aware of the roles and ethics of HVAC &R engineers in related industries.
CO2. Present the impact of professional engineering solutions in societal and environmental contexts.
CO3. Performance of HVAC &R systems Evaluate
CO4. Develop awareness of the engineering and technological aspects in the HVAC&R industries.
CO5. Communicate effectively through the preparation ofreport and practical presentation.
CO6. Analyse of HVAC&R in various application

Subject: Measurements and Automation (MESBL601)

CO1. Apply an inspection gauge to check or measure surface parameters.
CO2. Measure surface parameters using precision measurement tools and equipment.
CO3. Measure different mechanical parameters by using sensors.
CO4. Analyze the response of a control system.
CO5. Demonstrate use of automated controls using pneumatic and hydraulic systems.
CO6. Implement program on PLC system and demonstrate its application

Subject: Mini Project - 2B (MEPBL601)

CO1. Identify problems based on societal /research needs.
CO2. Apply Knowledge and skill to solve societal problems in a group.
CO3. Develop interpersonal skills to work as member of a group or leader.
CO4. Draw the proper inferences from available results through theoretical/
CO5. experimental/simulations.
CO6. Analyse the impact of solutions in societal and environmental context for sustainable development.
CO7. Use standard norms of engineering practices
CO8. Excel in written and oral communication.
CO9. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
CO10. Demonstrate project management principles during project work.

Course Outcomes R2016 University of Mumbai Syllabus
(Choice Based Credit Grading System)
Fourth Year (7th Semester CBCGS)
Subject: Machine Design – II (MEC701)

CO1. Select appropriate gears for power transmission on the basis of given load and speed
CO2. Design gears based on the given conditions.
CO3. Select bearings for a given applications from the manufacturers catalogue.
CO4. Select and/or design belts and flywheel for given applications
CO5. Design cam and follower mechanisms.
CO6. Design clutches and brakes

Subject: CAD/CAM/CAE (MEC702)

CO1. Identify proper computer graphics techniques for geometric modelling.
CO2. Transform, manipulate objects & store and manage data.
CO3. CAM Toolpath Creation and NC- G code output.
CO4. Use rapid prototyping and tooling concepts in any real life applications.
CO5. Identify the tools for Analysis of a complex engineering component.

Subject: Production Planning and Control (MEC703)

CO1. Illustrate production planning functions and manage manufacturing functions in a better way
CO2. Develop competency in scheduling and sequencing of manufacturing operations
CO3. Forecast the demand of the product and prepare an aggregate plan
CO4. Develop the skills of Inventory Management and cost effectiveness
CO5. Create a logical approach to Line Balancing in various production systems
CO6. Implement techniques of manufacturing planning and control

Subject: MECHANICAL VIBRATION (MEDLO7031)

CO1. Develop mathematical model to represent dynamic system.
CO2. Estimate natural frequency of mechanical element / system.
CO3. Analyse vibratory response of mechanical element / system.
CO4. Estimate the parameters of vibration isolation system and
CO5. Control the vibrations to the acceptable level using basic vibration principles
CO6. Handle the vibration measuring instruments

Subject: AUTOMOBILE ENGINEERING (MEDLO7032)

CO1. Illustrate the types and working of clutch and transmission system.
CO2. Demonstrate the working of different types of final drives, steering gears and braking systems
CO3. Illustrate the constructional features of wheels, tyres and suspension systems
CO4. Demonstrate the understanding of types of storage, charging and starting systems
CO5. Identify the type of body and chassis of an automobile
CO6. Comprehend the different technological advances in automobile

Subject: Pumps, Compressors and Fans (MEDLO7033)

CO1. Select suitable Pump
CO2. Design a reciprocating pump and analyse its performance
CO3. Design a centrifugal pump and analyse its performance

CO4.   Demonstrate basic principles of fans and blowers
CO5.   Design fan/blower and analyse its performance
CO6.   Design a compressor and analyse its performance

Subject: Computational Fluid Dynamics (MEDLO7034)

CO1.   Demonstrate methodology to work with CFD
CO2.   Illustrate principles of grid generation and discritisation methods
CO3.   Identify and apply specific boundary conditions relevant to specific application
CO4.   Decide solution parameters relevant to specific application
CO5.   Analyze the results and draw the appropriate inferences
CO6.   Demonstrate basic principles of FVM

Subject: Product Life Cycle Management (ILO7011)

CO1.   Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
CO2.   Illustrate various approaches and techniques for designing and developing products.
CO3.   Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
CO4.   Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Subject: Reliability Engineering (ILO7012)

CO1.   Understand and apply the concept of Probability to engineering problems
CO2.   Apply various reliability concepts to calculate different reliability parameters
CO3.   Estimate the system reliability of simple and complex systems
CO4.   Carry out a Failure Mode Effect and Criticality Analysis

Subject: Management Information System (ILO7013)

CO1.   Explain how information systems Transform Business
CO2.   Identify the impact information systems have on an organization
CO3.   Describe IT infrastructure and its components and its current trends
CO4.   Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
CO5.   Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Subject: Design of Experiments (ILO7014)

CO1.   Plan data collection, to turn data into information and to make decisions that lead to appropriate action
CO2.   Apply the methods taught to real life situations
CO3.   Plan, analyze, and interpret the results of experiments

Subject: Operations Research (ILO7015)

CO1.   Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
CO2.   Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
CO3.   Solve specialized linear programming problems like the transportation and assignment

problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.

CO4.   Understand the applications of integer programming and a queuing model and compute important performance measures

Subject: Cyber Security and Laws (ILO7016)

CO1.   Understand the concept of cybercrime and its effect on outside world
CO2.   Interpret and apply IT law in various legal issues
CO3.   Distinguish different aspects of cyber law
CO4.   Apply Information Security Standards compliance during software design and development

Subject: Disaster Management and Mitigation Measures (ILO7017)

CO1.   Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
CO2.   Plan of national importance structures based upon the previous history.
CO3.   Get acquainted with government policies, acts and various organizational structures associated with an emergency.
CO4.   Get to know the simple do's and don'ts in such extreme events and act accordingly.

Subject: Energy Audit and Management (ILO7018)

CO1.   To identify and describe present state of energy security and its importance.
CO2.   To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
CO3.   To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
CO4.   To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
CO5.   To analyze the data collected during performance evaluation and recommend energy saving measures

Subject: Development Engineering (ILO7019)

CO1.   Apply knowledge for Rural Development.
CO2.   Apply knowledge for Management Issues.
CO3.   Apply knowledge for Initiatives and Strategies
CO4.   Develop acumen for higher education and research.
CO5.   Master the art of working in group of different nature.
CO6.   Develop confidence to take up rural project activities independently

Subject: Machine Design –II (MEL701)

CO1.   Design gears based on the given conditions
CO2.   Design gearbox for a given application

CO3.   Design cam & followers for a given condition
CO4.   Design clutches for a given application
CO5.   Design brakes for given condition
CO6.   Select bearings for a given applications from the manufacturers catalogue

Subject: CAD/CAM/CAE (MEL702)

CO1.   Identify proper computer graphics techniques for geometric modelling.
CO2.   Transform, manipulate objects as well as store and manage data.
CO3.   Create CAM Toolpath and prepare NC- G code
CO4.   Apply rapid prototyping and tooling concepts in any real life applications.
CO5.   Identify the tools for Analysis of a complex engineering component.

Subject: Production Planning and Control (MEL703)

CO1.   Prepare a process sheet
CO2.   Prepare a Gantt Chart
CO3.   Forecast the demand of the product and prepare an aggregate plan.
CO4.   Perform ABC analysis of a given problem
CO5.   Develop the skills of Inventory Management and cost effectiveness.
CO6.   Create a logical approach to Line Balancing for various production systems.

Fourth Year (8th Semester CBCGS)
Subject: Design of Mechanical Systems (MEC801)

CO1. Apply the concept of system design.
CO2. Design material handling systems such as hoisting mechanism of EOT crane,
CO3. Design belt conveyor systems
CO4. Design engine components such as cylinder, piston, connecting rod and crankshaft
CO5. Design pumps for the given applications
CO6. Prepare layout of machine tool gear box and select number of teeth on each gear

Subject: Industrial Engineering and Management (MEC802)

CO1. Illustrate the need for optimization of resources and its significance
CO2. Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
CO3. Demonstrate the concept of value analysis and its relevance.
CO4. Manage and implement different concepts involved in method study and understanding of work content in different situations.
CO5. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
CO6. Illustrate concepts of Agile manufacturing, Lean manufacturing and Flexible manufacturing

Subject: Power Engineering (MEC803)

CO1. Compute heat interactions in combustion of reactive mixtures
CO2. Differentiate boilers, boiler mountings and accessories
CO3. Calculate boiler efficiency and assess boiler performance
CO4. Demonstrate working cycles of gas turbines
CO5. Draw velocity triangles of impulse/reaction turbines and calculate performance parameters/efficiency
CO6. Demonstrate basic working of pumps

Subject: Power Plant Engineering (MEDLO8041)

CO1. Comprehend various equipment/systems utilized in power plants
CO2. Demonstrate site selection methodology, construction and operation of Hydro Electric Power Plants
CO3. Discuss working, site selection, advantages, disadvantages of steam power plants
CO4. Discuss operation of Combined Cycle Power Plants
CO5. Discuss types of reactors, waste disposal issues in nuclear power plants
CO6. Illustrate power plant economics

Subject: Rapid Prototyping (MEDLO8042)

CO1. Select the feasible RP process
CO2. Select the feasible RP material
CO3. Gauge and Hybridize the ever-evolving Prototyping Technologies
CO4. Contribute towards the Product Development at the respective domain in the industry
CO5. Apply RP to build working prototypes

CO6.   Demonstrate basics of virtual reality

Subject: Renewable Energy Sources (MEDLO8043)

CO1.   Demonstrate need of different renewable energy sources
CO2.   Discuss importance of renewable energy sources
CO3.   Discuss various renewable energy sourses in Indian context
CO4.   Calculate and analyse utilization of solar and wind energy
CO5.   Illustrate design of biogas plant
CO6.   Demonstrate basics of hydrogen energy

Subject: Energy Management in Utility Systems (MEDLO8044)

CO1.   Demonstrate general aspects of energy management
CO2.   Summarize and explain need for energy management, economics and auditing
CO3.   Illustrate basics of energy economics and financial analysis techniques
CO4.   Describe importance of thermal and electrical utilities maintenance
CO5.   Assess potential and summarise benefits of waste heat recovery and cogeneration
CO6.   Illustrate waste heat recovery and cogeneration methods

Subject: Project Management (ILO 8021)

CO1.   Apply selection criteria and select an appropriate project from different options.
CO2.   Write work break down structure for a project and develop a schedule based on it.
CO3.   Identify opportunities and threats to the project and decide an approach to deal with them strategically.
CO4.   Use Earned value technique and determine & predict status of the project.
CO5.   Capture lessons learned during project phases and document them for future reference

Subject: Finance Management (ILO 8022)

CO1.   Understand Indian finance system and corporate finance
CO2.   Take investment, finance as well as dividend decisions

Subject: Entrepreneurship Development and Management (ILO 8023)

CO1.   Understand the concept of business plan and ownerships
CO2.   Interpret key regulations and legal aspects of entrepreneurship in India
CO3.   Understand government policies for entrepreneurs

Subject: Human Resource Management (ILO 8024)

CO1.   Understand the concepts, aspects, techniques and practices of the human resource management.
CO2.   Understand the Human resource management (HRM) processes, functions, changes and challenges in
CO3.   today's emerging organizational perspective.
CO4.   Gain knowledge about the latest developments and trends in HRM.
CO5.   Apply the knowledge of behavioural skills learnt and integrate it with in interpersonal and intergroup environment emerging as future stable engineers and managers.

Subject: Professional Ethics and Corporate Social Responsibility (CSR) (ILO 8025)

CO1.   Understand rights and duties of business
CO2.   Distinguish different aspects of corporate social responsibility
CO3.   Demonstrate professional ethics

CO4. Understand legal aspects of corporate social responsibility

Subject: Research Methodology (ILO 8026)

CO1. Prepare a preliminary research design for projects in their subject matter areas
CO2. Accurately collect, analyses and report data
CO3. Present complex data or situations clearly
CO4. Review and analyses research findings

Subject: IPR and Patenting (ILO 8027)

CO1. Understand Intellectual Property assets
CO2. Assist individuals and organizations in capacity building
CO3. Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Subject: Digital Business Management (ILO 8028)

CO1. Identify drivers of digital business
CO2. Illustrate various approaches and techniques for E-business and management
CO3. Prepare E-business plan

Subject: Environmental Management (ILO 8029)

CO1. Understand the concept of environmental management
CO2. Understand ecosystem and interdependence, food chain etc.
CO3. Understand and interpret environment related legislations

Subject: Design of Mechanical Systems (MEL 801)

CO1. Apply the concept of system design.
CO2. Design of hoisting mechanism of EOT crane,
CO3. Design belt conveyor systems
CO4. Design pumps for the given applications
CO5. Design engine components such as cylinder, piston, connecting rod and crankshaft
CO6. Design of machine tool gearbox

Subject: Power Engineering (MEL 802)

CO1. Differentiate boilers
CO2. Differentiate boiler mountings and accessories
CO3. Conduct a trial on impulse turbine and analyse its performance
CO4. Conduct a trail on reaction turbine and analyse its performance
CO5. Conduct a trial on Centrifugal pump and analyse its performance
CO6. Conduct a trial on Reciprocating pump and analyse its performance

Subject: Project (I and II) (MEP 701/ MEP 801)

CO1. Do literature survey/industrial visit and identify the problem
CO2. Apply basic engineering fundamental in the domain of practical applications
CO3. Cultivate the habit of working in a team
CO4. Attempt a problem solution in a right approach
CO5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
CO6. Prepare a report as per the standard guidelines.

Course outcome R-2019 University of Mumbai Syllabus (Choice Based Credit Grading System)

Second Year
Third Sem (CBCS)

SUBJECT: Engineering Mathematics-III (CEC 301)
Course Outcomes:
1.   Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2.   Apply the concept of inverse Laplace transform of various functions in engineering problems.
3.   Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4.   Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5.   Apply Matrix algebra to solve the engineering problems.
6.   Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

SUBJECT: Mechanics of Solids (CEC 302)
Course Outcomes:
1.   Evaluate stress - strain behavior of elastic members and thin cylinders subjected to internal pressure.
2.   Draw variation of axial force, shear force and bending moment diagram for statically determinate beams and frames.
3.   Calculate Moment of Inertia for cross sections and analyse the material response under the action of shear and the effect of flexure (bending).
4.   Predict the angle of twist and shear stress developed in torsion and compute direct and bending stresses developed in the cross section of centrally and eccentrically loaded columns.
5.   Locate principal planes in members and calculate principal stresses using analytical and graphical method and to calculate strain energy stored in members due to elastic deformation.

6.   Evaluate slope and deflection of beams supported and loaded in different ways.

SUBJECT: Engineering Geology (CEC 303)
Course Outcomes:
1.   Explain the concepts of Geology and its application for safe, stable and economic design of any civil engineering structure.
2.   Interpret the lithological characters of the rock specimen and distinguish them on the basis of studied parameters.
3.   Describe the structural elements of the rocks and implement the knowledge for collection and analysis of the geological data.
4.   Interpret the geological conditions for the dam site and calculate RQD for the assessment of rock masses.
5.   Analyze the given data and suggest rock mass rating for assessment of tunnelling conditions.
6.   Interpret the causes of geological hazards and implement the knowledge for their prevention.

SUBJECT: Architectural Planning & Design of Buildings (CEC304)

Course Outcomes:

1. Remember and recall the intricate details of building design and drawing.
2. Understand the basic concepts of building design and drawing.
3. Learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
4. Identify, analyze, research literate and solve complex building design and drawing problems.
5. Have new solutions for complex building design and drawing problems.
6. Effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

SUBJECT: Fluid Mechanics – I (CEC305)

Course Outcomes:

1. Describe various properties of fluids and types of flow
2. Determine the pressure difference in pipe flows, application of Continuity equation and Bernoulli's theorem to determine velocity and discharge
3. Apply hydrostatic and dynamic solutions for fluid flow applications
4. Analyse the stability of floating bodies
5. Apply the working concepts of various devices to measure the flow through pipes and channels.
6. Explain the compressible flow, propagation of pressure waves and stagnation properties

SUBJECT: Mechanics of Solids- LAB (CEL301)

Course Outcomes:

1. Evaluate stress - strain behavior of materials and assess the structural behavior by the virtue of stresses developed and deformation of elastic members.
2. Analyze the material response under the action of shear and the effect of flexure (bending).
3. Predict the angle of twist and shear stress developed in torsion.
4. Evaluate slope and deflection of beams supported and loaded in different ways.

SUBJECT: Engineering Geology Lab. Practice (CEL302)

Course Outcomes:

1. Identify various rock forming minerals on the basis of physical properties.
2. Explain the characteristics of Igneous, Sedimentary and Metamorphic rocks and assess their suitability as construction material and foundation rock.
3. Interpret the rock characteristics and comment on their suitability as water bearing horizons.
4. Interpret the geological map and assess the suitability of the site for Civil Engineering works.
5. Solve the borehole problems and interpret it in order to understand subsurface Geology of the area.
6. Calculate RQD and evaluate the rock masses for Civil Engineering Works.

SUBJECT: Architectural Planning & Design of Buildings Lab (CEL303)

Course Outcomes:

1.   Plan and design of residential and public building by implementing the principles of planning of buildings, Green building principles, byelaws, regulations and codesfor planning
2.   Preparing various working and detailed drawing of the buildings in CAD.
3.   Preparing layouts of various building services.
4.   Preparing perspective views for all types of buildings
5.   Preparing the reports based on the drawings prepared, if required

SUBJECT: Fluid Mechanics – I (Lab) (CEL304)
Course Outcomes:
1.   Calculate the metacentric height
2.   Verify the Bernoulli's theorem
3.   Determine the discharge coefficients
4.   Measure fluid flow using various devices
5.   Determine the hydraulic coefficients of an orifice

SUBJECT: Skill Based Lab Course-I Computer Aided Drafting & Building Information Modelling (CEL305)
Course Outcomes:
1.   Transfer the plan from a drawing sheet to a 2-D drafting software
2.   Visualize the various elements in the software like points, lines, polygons, etc. as objects of the real world and relate it with civil engineering components.
3.   Apply civil engineering concepts to draft efficient civil engineering plans in accordance to various building bye laws and forms.
4.   Conceptualize the space, logistic and statutory constraints in the real world to draw an efficient plan so that optimization is achieved.
5.   Attach and retrieve information pertaining to various civil engineering components through 3-D modelling software.
6.   Demonstrate a virtual walk through of buildings

SUBJECT: Mini Project 1A (CEM301)
Course Outcomes:
1.   Identify problems based on societal /research needs.
2.   Apply Knowledge and skill to solve societal problems in a group.
3.   Develop interpersonal skills to work as member of a group or leader.
4.   Draw the proper inferences from available results through theoretical/ experimental/simulations.
5.   Analyse the impact of solutions in societal and environmental context for sustainable development.
6.   Use standard norms of engineering practices
7.   Excel in written and oral communication.
8.   Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9.   Demonstrate project management principles during project work.

Course outcome R-2019 University of Mumbai Syllabus (Choice Based Credit Grading System) Second Year

Fourth Sem (CBCS)

SUBJECT: Engineering Mathematics-IV (CEC 401)

Course Outcomes:

1.   Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.

2.   Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.

3.   Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.

4.   Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.

5.   Apply the concept of probability distribution to engineering problems& Testing hypothesis of small samples using sampling theory.

6.   Apply the concepts of parametric and nonparametric tests for analysing practical problems

SUBJECT: Structural Analysis (CEC402)

Course Outcomes:

1.   Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3- Hinged arches.

2.   Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..

3.   Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.

4.   Apply Flexibility methods and make use of Clapeyron's Theorem to analyze the indeterminate structures.

5.   Analyse the indeterminate structures such as beams & simple rigid jointed frames using direct stiffness method. Analyse the indeterminate structures using Moment Distribution as Stiffness method and make plastic analysis.

SUBJECT: Surveying (CEC403)

Course Outcomes:

1.   Apply the principles of surveying and field procedures to conduct the various surveys
2.   Use various methods for taking linear and angular measurements
3.   Collect, record and analyse the field data for preparing drawings.
4.   Explain the advancements in instruments and methods
5.   Calculate the area of land and volume of earthwork
6.   Set out curves

SUBJECT: Building Materials & Concrete Technology (CEC 404)

Course Outcomes:

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1.   To develop and implement the conceptual knowledge of building materials in the construction industry.
2.   Assess the properties of building stones and their classifications. Understand the concept of various methods of manufacturing of bricks and different types of concrete blocks.
3.   To expose students to various quality control aspects of civil engineering materials by performing different lab tests on materials.
4.   Identify the ingredients and properties of fresh and hardened concrete.
5.   To interpret and design concrete mix for various grades for various exposure conditions.
6.   To study the new technology for manufacturing, testing and quality of concrete

SUBJECT: Fluid Mechanics – II (CEC405)

Course Outcomes:

1.   Analyze flow through pipes, various losses through pipes, pipe network and power transmission through nozzle
2.   Explain the concept of Laminar flow and velocity distribution through parallel plates andpipes
3.   Explain the concept of Turbulent flow and velocity distribution in pipes
4.   Describe boundary layer concept , boundary layer separation and flow around submerged bodies
5.   Apply Moment of Momentum Principle.
6.   Explain the importance of dimensionless numbers, dimensional analysis and similarity behavior of model and prototype.

SUBJECT: Structural Analysis Tutorial (CEL401)

Course Outcomes:

1.   Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2.   Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3.   Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4.   Analyse the indeterminate structures such as beams & simple rigid jointed frames using Flexibility methods and direct stiffness method.

SUBJECT: Surveying(Lab) (CEL402)

Course Outcomes:

1.   Operate and use the surveying instruments according to the accuracy and suitability.
2.   Measure linear and angular dimensions in horizontal and vertical planes.
3.   Collect, record and analyse the field data systematically.
4.   Prepare plans of the existing features on the ground, sections and contours.
5.   Compute the area of land and the volume of earthwork.
6.   Set out curves and foundation plans.

SUBJECT: Building Materials & Concrete Technology (Lab) (CEL 403)

Course Outcomes:

1. Develop collaborative skills to work in a team/group
2. Test physical properties of cement, aggregates and concrete.
3. Test various other building materials like tiles, bricks and timber
4. Evaluate the effects of admixtures on physical properties of concrete.
5. Design the concrete mix.
6. To bridge the gap between theoretical and market/industrial practices by market surveys.

SUBJECT: Fluid Mechanics – II (Lab) (CEL404)
Course Outcomes:
1. Verify the Reynold's experiment
2. Estimate the viscosity of fluid
3. Calculate the losses in pipes
4. Assess the flow pattern and velocity distribution in pipe flow
5. Earn the water hammer phenomenon through demonstration
6. Learn the wind tunnel testing through demonstration.

SUBJECT: Skill Based Lab Course-II
Total Station and Geographical Information System (CEL405)
Course Outcomes:
1. Operate a Total Station and traverse the field
2. Perform various operations like computing height of a structure, computing area of plot, subdividing area, demarcating boundaries, etc. Using Total Station
3. Set out foundation plan using Total Station
4. Compute the point, line and area features using Global Navigation Satellite System
5. Plot various existing features in a geographic area on a GIS platform
6. Add attribute and perform various statistical operations in GIS

SUBJECT: Mini Project -1B (CEM 401)
Course Outcomes:
1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9. Demonstrate project management principles during project work.

Course outcome R-2019 University of Mumbai Syllabus (Choice Based Credit Grading System) Third Year V   Sem (CBCS)

SUBJECT: Theory of Reinforced Concrete Structures (CEC501)
Course Outcomes:
1.   Understand the fundamentals of WSM and LSM.
2.   Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.
3.   Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.
4.   Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method

SUBJECT: Applied Hydraulics (CEC502)
Course Outcomes:
1   Describe impact of jet on stationary, moving, hinged and series of plates also solve the numerical based on forces acting on it.
2   Distinguish various types of turbines, Characteristic curves and its components.
3   Analyze Centrifugal pumps by incorporating velocity triangle diagrams.
4   Know the working mechanism of various Hydraulic machines.
5   Identify the hydraulic behaviour of open channel flow and design the most economical section of channels.
6   Explain mathematical relationships for hydraulic jumps, surges, and critical, uniform, and gradually-varying flows.

SUBJECT: Geotechnical Engineering-I (CEC503)
Course Outcomes:
1   Explain the basic concepts of the physical and engineering properties of soil and derive the relationships among various unit weights & other parameters.
2   Comprehend clay mineralogy and plasticity behaviour of clay.
3   Analyze grain size distribution of soil and classify the soil as per IS code.
4   Evaluate the coefficient of permeability of different types of soils and draw the flow net diagram to estimate seepage discharge.
5   Compute the effective stress and pore water pressure inside the soil mass under different geotechnical conditions.
6   Evaluate the compaction parameters in laboratory and field as well as understand the necessity and methods of soil exploration

SUBJECT: Transportation Engineering (CEC504)
Course Outcomes:
1   Compare various modes of transportation and understand basic technical aspects of railways, airways and waterways.
2   Understand different road plans, requirements of alignments and Design horizontal and vertical geometrical elements of highways.
3   Carry out different traffic studies and analyze basic parameters of traffic engineering for efficient planning and control of traffic.
4   Design the flexible and rigid pavement as per relevant IRC codes.
5   Construct different types of pavements, use of soil stabilization and planning of highway drainage.

6   Carry out structural and functional evaluation of pavement, identify the failures and design the overlay

SUBJECT: Department Level Optional Course - 1 Modern Surveying Instruments and Techniques (CEDLO5011)

Course Outcomes:

1   Compare modern surveying instruments with conventional instruments.
2   Elucidate the utility of geoinformatics in surveying data collection and analysis.
3   Explain the utility of Aerial photogrammetry in surveying works.
4   Highlight the improvement in land record keeping and governance using modern tools.
5   Describe the procedure of hydrographic surveying and mapping.
6   Apply modern surveying tools to solve complex problems and demonstrate essential skills for working on surveying software.

SUBJECT: Department Level Optional Course - 1 Building Services and Repairs (CEDLO5012)

Course Outcomes:

1   Apply the knowledge of working & installation of mechanical utility services in buildings.
2   Understand the electrical supply lines, materials, safety devices and illumination systems used in buildings.
3   Investigate and learn operations and adopt appropriate materials in plumbing systems & integrate the same into the building projects.
4   Assess the structural health of the buildings & adopt repair strategy to the damaged structures.
5   Implement the right methods and materials for repairing the concrete structures and also decide the sequence of operations.
6   Create and understand proper documentation process and adopt practices for safety for protection of men and materials on the repair site.

SUBJECT: Department Level Optional Course - 1 Sustainable Building Materials (CEDLO5013)

Course Outcomes:

1   Explain sustainable practices by utilizing engineering practices.
2   Able to understand different types of environmental problems and their sustainable solution.
3   Suggest appropriate type of masonry unit and mortar for civil engineering constructions.
4   Analyze different alternative building materials for construction.
5   To suggest suitable alternative building technologies for sustainable development.
6   To propose different roofing systems and use of waste materials in construction Industry

SUBJECT: Department Level Optional Course - 1 Advanced Structural Mechanics (CEDLO5014)

Course Outcomes:

1   Understand the concept of unsymmetrical bending, shear centre for thin-walled open sections and springs.
2   Analyze hooks, circular closed rings, chain links with straight length & semi-circular ends using the concept of beam curved in elevation.

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3   Analyze the beam curved in plan for different support conditions.

4   Study the behavior of beam resting on elastic foundation with various loading conditions.

5   Understand the concept of different theories of failure in different sections.

6   Determine deflection of deep beams, shear correction factor for different sections like solid & hollow sections.

SUBJECT: Department Level Optional Course - 1 Air and Noise Pollution and Control (CEDLO5015)

Course Outcomes:

1   Identify air and noise pollution problems and interpret criteria for air and noise quality data.

2   Recognize various environmental transformation processes of pollutants under extreme weather condition.

3   Interpret meteorological data and develop capability to assessment of project proposal.

4   Knowledge to analyze quality of air in the form of air quality index and dispersion modeling.

5   Relate and analyze the pollution regulation on its scientific basis.

6   Justify the use of pollution control equipment and their design

SUBJECT: Department Level Optional Course - 1 Transportation Planning and Economics (CEDLO5016)

Course Outcomes:

1   Understand various Urban transport related terms and policies along with methods to carry out planning surveys.

2   Carry out trip generation, trip distribution, modal split and traffic assignment for planning of urban transport system.

3   Apply land use transport models at Urban area.

4   Carry out economic analysis of different Transport related Infrastructure projects by analyzing costs and benefits related to projects using NPV, IRR and B/C ratio method.

5   Estimate capacity of different public transportation modes in Urban area and to plan and schedule the same based on fleet size.

6   Plan and design Parking facility at Urban area

SUBJECT: Department Level Optional Course – 1 Advanced Concrete Technology (CEDLO5017)

Course Outcomes:

1   To use the various concrete materials and demonstrate the fresh properties of concrete.

2   To perform different testing methods of concrete.

3   To describe the durability of concrete and apply the knowledge of durability in extreme weather concreting.

4   To design the concrete mix for field application by different methods.

5   To explain the various properties of special concrete.

6   To discuss the quality of concrete and explain the acceptance criteria.

SUBJECT: Theory of Reinforced Concrete Structures (Lab) CEL501

Course Outcomes:

1   Understand the fundamentals of WSM and LSM.

2   Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.

3   Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.

4   Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method

SUBJECT: Applied Hydraulics (Lab) CEL502

Course Outcomes:

1   Evaluate the efficiencies and discuss the working of various pumps and turbines.

2   Apply impulse momentum principle to hydraulic machines.

3   Determine the rate of flow through open channel.

4   Generate and evaluate Gradually varied flow (GVF) and Rapid varied Flow (RVF) in open channel flow.

5   Compute the Chezy's Constant through tilting flume

SUBJECT: Geotechnical Engineering – I (Lab) CEL503

Course Outcomes:

1   Determine the physical and engineering properties of soil

2   Determine the plasticity characteristics of soil

3   Carry out sieve analysis of soil, plot grain size distribution curve and determine the IS classification of soil

4   Determine coefficient of permeability of soils

5   Determine the compaction characteristics of soils

6   Compute the field SPT 'N' value and prepare the bore lo

SUBJECT: Transportation Engineering (Lab) (CEL504)

Course Outcomes:

1   Classify Bitumen on basis of Penetration and Viscosity grade.

2   Select Bitumen as per suitability on basis of Softening point and Ductility value.

3   Determine suitability of aggregate on basis of Impact value, Abrasion value and Crushing value.

4   Differentiate Elongated and Flaky aggregates on basis of Shape test.

5   Carry out Classified volume study at mid-block section of road.

6   Plot speed profile curve (S-Curve) at mid-block section

SUBJECT: Professional Communication and Ethics CEL505

Course Outcomes:

1   Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.

2   Strategize their personal and professional skills to build a professional image and meet the demands of the industry.

3   Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.

4   Deliver persuasive and professional presentations.

5   Develop creative thinking and interpersonal skills required for effective professional communication.

6   Apply codes of ethical conduct, personal integrity and norms of organizational behaviour

SUBJECT: Mini Project -2A CEM501 Course Outcomes:

1   Identify problems based on societal /research needs and formulate a solution strategy.

2   Apply fundamentals to develop solutions to solve societal problems in a group

3   Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.

4   Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.

5   Draw the proper inferences from available results through theoretical/ experimental/ simulations and assemble physical systems.

6   Create devises or design a computer program or develop computer application

SUBJECT: Transportation Engineering (Lab) (CEL504)
Course Outcomes:
1   Classify Bitumen on basis of Penetration and Viscosity grade.
2   Select Bitumen as per suitability on basis of Softening point and Ductility value.
3   Determine suitability of aggregate on basis of Impact value, Abrasion value and Crushing value.
4   Differentiate Elongated and Flaky aggregates on basis of Shape test.
5   Carry out Classified volume study at mid-block section of road.
6   Plot speed profile curve (S-Curve) at mid-block section

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SUBJECT: Transportation Engineering (Lab) (CEL504)
Course Outcomes:
1   Classify Bitumen on basis of Penetration and Viscosity grade.
2   Select Bitumen as per suitability on basis of Softening point and Ductility value.
3   Determine suitability of aggregate on basis of Impact value, Abrasion value and Crushing value.
4   Differentiate Elongated and Flaky aggregates on basis of Shape test.
5   Carry out Classified volume study at mid-block section of road.
6   Plot speed profile curve (S-Curve) at mid-block section

Course outcome R-2019 University of Mumbai Syllabus (Choice Based Credit Grading System)
Third Year VI   Sem (CBCS)

SUBJECT: Design and Drawing of Steel Structures (CEC601)
Course Outcomes:

1   Use the knowledge of Limit State Design philosophy as applied to steel structures. IS 800 code clauses

2   Design bolted and welded connections.

3   Design members subjected to axial tension.

4   Design compression members, Built-up columns and column bases.

5   Design members subjected to bending moment, shear force etc.

6   Estimate design loads as per IS 875 for roof truss and design the Steel roof truss.

SUBJECT: Water Resources Engineering (CEC602)

Course Outcomes:

1   Describe National Water Policy, Calculate Crop water requirement and Classify various types and methods of irrigation.

2   Estimate flood discharge and Runoff by traditional and modern usage tools for planning and management of water resources projects.

3   Apply knowledge on ground water, well hydraulics to estimate the safe yield and ground water potential

4   Analyze and design gravity dams and earthen dams with spillways for sustainable development

5   Compare different silt theories related to irrigation channel and design the same.

6   Classify and Explain various canal structures and suggest remedial measures for water logging to save fertile irrigation

SUBJECT: Geotechnical Engineering-II (CEC603)

Course Outcomes:

1   Evaluate the consolidation parameters for the soil.

2   Calculate the shear strength parameters for the soil.

3   Calculate the factors of safety of different types of slopes under various soil condition, analyze the stability of slopes.

4   Calculate lateral earth pressure under various soil condition.

5   Calculate bearing capacity of shallow foundations using theoretical and field methods.

6   Calculate load carrying capacity of individual as well as group of pile foundation using theoretical and field methods and pile settlement.

SUBJECT: Environmental Engineering (CEC604)

Course Outcomes:

1   Analyse the quality of water and make outline of water Supply scheme.

2   Design the various units of water treatment plant and apply the advanced, miscellaneous treatments whenever necessary.

3   Build service connection of water supply from main and building drainage system at construction site along with rain water harvesting layout.

4   Analyse and plan sewerage system along with test for sewer line.

5   Design the units of sewage treatment plant. Also, able to apply the knowledge of lowcost treatment and stream sanitation.

6   Understand air pollution, noise pollution and functional elements of solid waste management.

SUBJECT: Department Level Optional Course -2 Rock Mechanics (CEDLO6011)

Course Outcomes:

1 Explain basic concepts of Rock -Mechanics and apply it to design aspects of various Civil Engineering structures on or through the rocks.

2 Classify the rock masses and evaluate them for various Civil Engineering works.

3 Explain the laboratory testing of rocks and determine the physical properties and strength of intact rocks and rock masses.

4 Explain the stress-strain responses of the rocks and influencing factors.

5 Determine the bearing capacity and factor of safety of rocks.

6 Determine the stability of slopes and underground excavations.

SUBJECT: Department Level Optional Course - 1
Biological Process and Contamination Removal (CEDLO6012)

Course Outcomes:

1 Determine and analyze the characteristics of wastewater and decide the treatment for wastewater.

2 Understand biological treatment process and necessity of contamination removal

3 Understand and apply the concepts of advancements/emerging techniques of Microbial Growth Kinetics, Utilization of soluble substrate and biotechnological remedies.

4 Summarize the concept of aerobic decomposition and its application in Aerobic Suspended Growth Biological Treatment Systems

5 Summarize the concept of the anaerobic decomposition and its application in wastewater treatment.

6 To derive the knowledge and develop rational approaches towards natural and biotechnological Methods for contamination removal

SUBJECT: Department Level Optional Course-2 Construction Equipment & Techniques (CEDLO6013)

Course Outcomes:

1 Understand the use/applications of various conventional construction equipments and select the best out of them for a particular site requirement.

2 Know modern methods/equipments used for underground as well as underwater tunnelling.

3 Compare conventional and modern methods of formwork and get acquainted with techniques used on sites with restricted space.

4 Understand the techniques involved and the equipments required thereof for laying of utility lines, bridge construction and installation of structural steel members.

5 Gain knowledge about the setting up of different kinds of the power generating structures.

6 Get acquainted with the equipment's/ techniques for construction of transporting facilities.

SUBJECT: Department Level Optional Course -2 Urban Infrastructure Planning (CEDLO6014)

Course Outcomes:

1 Explain the concepts related to planning of modern cities, GDP contribution, RERA, affordable housing

2 Elaborate the economics involved in urban infrastructure planning

3 Envisage the various elements required for infrastructure development of a city and describe the concepts, significance and importance of each

4 Evaluate technical, social and economic feasibility of transportation projects within cities

5   Demonstrate modern tool usage for urban management and governance

6   Design environmentally safe and disaster resilient infrastructure

SUBJECT: Department Level Optional Course -2 Open Channel Flow (CEDLO6015)
Course Outcomes:

1   Describe the basic nature of flow in open channels, analyze the behaviour of flow and apply basic theories to design the optimum channel sections.

2   Demonstrate the energy concepts in open channel and its practical applications.

3   Apply dynamic equation for Gradually varied flow (GVF) and evaluate water profiles at different conditions in prismatic channels.

4   Differentiate between GVF and Rapidly Varied Flow (RVF), analyze hydraulic jump in open channel and its importance.

5   Explain the spatially varied flow and classify water profiles.

6   Discuss the temporal variations of flow in GVF and RVF in open channel.

SUBJECT: Department Level Optional Course - 1 Computational Structural Analysis (CEDLO6016)
Course Outcomes:

1   Formulate force displacement relation by flexibility and stiffness method

2   Analyze the plane trusses, continuous beams and portal frames by transformation approach

3   Analyze the structures by direct stiffness method

4   Explain the basics of finite element formulation.

5   Apply finite element formulations to solve one dimensional Problems

SUBJECT: Department Level Optional Course -2 Traffic Engineering and Management (CEDLO6017)
Course Outcomes:

1   Understand different characteristics of the road users and vehicles from their consideration and view point in the traffic engineering and transportation planning.

2   Conduct different traffic surveys, analyzing the data collected as a part of such studies and interpreting it with the help of the different statistical models.

3   Explain the concepts of PCU and LOS, their implication in determination of the capacity using Speed-Flow-Density relationships.

4   Discuss the aspects associated with road safety, its audit and different TSM measures.

5   Discuss transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.

6   Improve the effectiveness and efficiency of transportation systems through advanced technologies in Information systems and communication.

SUBJECT: Department Level Optional Course -2 Introduction to Offshore Engineering (CEDLO6018)
Course Outcomes:

1   To know various offshore construction methodologies

2   To addresses the general engineering concepts during construction stages.

3   To handle complexities and key engineering systems in ocean environment

SUBJECT: Design and Drawing of Steel Structures (Lab) (CEL601)

Course Outcomes:

1 Calculate dead, live and wind loads on the structure.
2 Analyze the structure by analytical/graphical method.
3 Use steel table for selecting appropriate section.
4 Design the members for various load combinations.
5 Design the bolted and welded connection.
6 Read and Prepare the detailed fabrication drawing and design report

SUBJECT: Water Resources Engineering (Lab) (CEL602)

Course Outcomes:

1 Classify various techniques of water distribution and compute water requirement of crops.
2 Discuss in detail about hydrological process and interpret plotting of hydrographs.
3 Apply their knowledge on well hydraulics and compute discharge from an aquifer.
4 Classify and describe various hydraulic structures such as dams and carry out its analysis for structural stability.
5 Compare different silt theories related to irrigation channel and design the same.
6 Identify and classify different canal head works - its distribution system and canal Structures

SUBJECT: Geotechnical Engineering-II Lab (CEL603)

Course Outcomes:

1 Determine consolidation parameters such as coefficient of compressibility, coefficient of volume change, coefficient of consolidation.
2 Determine cohesion and angle of shearing resistance for various soil types.
3 Determine the CBR value of soil for pavement design.
4 Determine swelling pressure of soil.
5 Understand the concept of stress distribution in soils due to vertically applied load. 6 Solve design problems using geotechnical software.

SUBJECT: Environmental Engineering (Lab) (CEL604)

Course Outcomes:

1 Impart the knowledge on quality or characteristic of water and wastewater sample.
2 Interpret the required treatment for water and wastewater based on standards and norms.
3 Impart the knowledge on quality of solid waste.
4 Measure the concentration of particulate matters, dust and dispersed pollutants in air.
5 Inspect the levels of noise and interpret the results

SUBJECT: Skill Based Lab Course-III (CEL605)

Course Outcomes:

1 To understand the functions involved various software's related to civil engineering field.
2 To perform different functions of the software related to analysing modelling and designing the structure, creation of database and its analysis.
3 To describe and represent the data obtained from site, experimental work in various formats as per industrial requirements

4   To import road geometric design into the software as well as relate with the design standards applied into the software.

5   To design the effective distribution network system for the distribution of water resources.

6   To apply the knowledge to create the programme in excel and various computer languages for solving problems pertaining to civil engineering field

SUBJECT: Mini Project -2B (CEM601)
Course Outcomes:

1   Identify problems based on societal /research needs and formulate a solution strategy.

2   Apply fundamentals to develop solutions to solve societal problems in a group.

3   Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.

4   Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.

5   Draw the proper inferences from available results through theoretical/experimental/simulations and assemble physical systems.

6   Create devises or design a computer program or develop computer application.

SUBJECT: Theory of Reinforced Concrete Structures (CEC501)
Course Outcomes:

1.   Understand the fundamentals of WSM and LSM.

2.   Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.

3.   Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.

4.   Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method

SUBJECT: Theory of Reinforced Concrete Structures (CEC501)
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SUBJECT: Theory of Reinforced Concrete Structures (CEC501)
Course Outcomes:

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2.   Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.

3.   Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.

4.   Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method

Course outcome R-2016 University of Mumbai Syllabus (Choice Based Credit Grading System)
Final Year 7th Sem (CBCS)

SUBJECT: Quantity Survey, Estimation & Valuation (CE-C 701)
Course Outcomes:

1. Apply the measurement systems to various civil engineering items of work.
2. Draft the specifications for various items of work & determine unit rates of items of works
3. Estimate approximate cost of the structures by using various methods & prepare detailed Estimates of various civil engineering structures by referring drawings.
4. Assess the quantities of earthwork &construct mass haul diagrams.
5. Draft tender notice &demonstrate the significance of the tender as well as contract Process.
6. Determine the present fair value of any constructed building at stated time.

SUBJECT: Theory of Reinforced Concrete Structures (CE-C 702)
Course Outcomes:
1. Understand the pros and cons of the WSM and LSM.
2. Understand the various clauses specified in IS: 456-2000 for designing structural members With the safety and economy.
3. Carry out analysis and design of various elements of the reinforced concrete structures Such as beam, slab, column, footings using the concept of Limit state method.
4. Understand and the use of readymade design curves from Special publications of Bureau Of Indian standards.

SUBJECT: Water Resources Engineering II (CE-C 703)
Course Outcomes:
1. Design the section of gravity dams, earth and rock fill dams, arch dams and buttress dams.
2. Design spillways and energy dissipaters.
3. Apply silt theories to design irrigation canals.
4. Explain various types of canals and its maintenance.
5. Explain different cross drainage works of a canal system.

SUBJECT: Department Level Elective: Pre-stressed Concrete (CE-DLO 7041)
Course Outcomes:
1. To understand the basic concept, application and behaviour of pre-stressing over that of The RC structure.
2. To have knowledge of modern engineering tools necessary for pre-tensioning and post- Tensioning technology.
3. To evaluate various losses occurring in pre-stressed concrete structure

4. To analyse the various pre-stressed components of the structure and design the same for Flexure as well as shear using relevant IS Code.
5. To analyze pre-stressed concrete members for limit state of serviceability for cracking And deflection.

SUBJECT: Department Level Elective: Solid Waste Management (CE-DLO 7042)
Course Outcomes:
1. Explain generation, storage, collection, transfer and transport, processing, recovery and Disposal in the management of solid waste.
2. Understand the characteristics of different types of solid waste and the factors affecting Variation.
3. Identify the methods of collection, storage and transportation of solid waste.

4. Suggest suitable technical solutions for processing of wastes.
5. Ability to plan waste minimization and disposal of municipal solid waste.
6. Ensure the safe handling and treatment of Hazardous, Electronic and Biomedical waste.

SUBJECT: Department Level Elective: Pavement Subgrade and Materials (CE-DLO 7043)

Course Outcomes:

On the successful completion of the course, the students shall be able to:

1. Understand the soil classification in accordance with various soil classify the system and Evaluate the ability of the soil as a subgrade material.
2. Understand the requirements and desirable properties of the various materials to be used In the construction of pavements.
3. Understand the characterization of different paving materials along with the tests to be Conducted on these materials.
4. Know the various ground improvement methods.
5. Understand subgrade soil strength in terms of standard engineering parameters.
6. Application of basic principles of mix design of cement concrete and bituminous mixes

SUBJECT: Department Level Elective: Structural Dynamics (CE-DLO 7044)

Course Outcomes:

1. Understand the difference between static and dynamic loads and analysis.
2. Evaluate the response of SDOF and Two DOF systems to different types of dynamic loads Including ground motions.
3. Understand the basics of random vibrations and the application of this concept
4. Analyze Linear SDOF systems.

SUBJECT: Department Level Elective: Applications of Geographic Information Systems & Remote Sensing (CE-DLO 7045)

Course Outcomes:

1. Explain the principles of physics of Electromagnetic radiation as applied to remote Sensing.
2. Describe Spatial and non-spatial database of geographic information system
3. Demonstrate the GPS Satellites & their Segments.
4. Apply the GIS & RS techniques in Urban Planning, Water Resources & Environmental Management.
5. Integrate the GIS-GPS & RS techniques for Infrastructure Management
6. Illustrate applications of GIS& RS in Disaster Management.

SUBJECT: Department Level Elective: Foundation Analysis and Design (CE-DLO 7046)

Course Outcomes:

1. Ability to identify, formulate and solve geotechnical engineering problem.
2. Ability to design a suitable foundation system from economic and safe aspects
3. Ability to design machine foundations
4. Ability to relate easily to allied subjects such soil dynamics; advanced engineering Geology, rock mechanics etc.

5. Ability to understand design of sheet pile
6. Ability to analyze vertical stresses developed in soil and used in practical problems

SUBJECT: Institute Level Elective: Product Life cycle Management (CE-C ILOC-7011)
Course Outcomes:
1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility Study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, Machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining And manufacturing plant.

SUBJECT: Institute Level Elective: Reliability Engineering (CE-C ILOC- 7012)
Course Outcomes:
1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis.

SUBJECT: Institute Level Elective: Management Information System (CE-C ILOC-7013)
Course Outcomes:
1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from Databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how They provide value for businesses.

SUBJECT: Institute Level Elective: Design of Experiments (CE-C ILOC- 7014)
Course Outcomes:
1. Plan data collection, to turn data into information and to make decisions that lead to appropriate Action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments.

SUBJECT: Institute Level Elective: Operation Research (CE-C ILOC- 7015)
Course Outcomes:
1. Understand the theoretical workings of the simplex method, the relationship between a Linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a Model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment Problems, solve network models like the shortest path, minimum spanning tree, and Maximum flow problems.

4. Understand the applications of integer programming and a queuing model and compute Important performance measures.

SUBJECT: Institute Level Elective: Cyber Security and Laws (CE-C ILOC-7016)
Course Outcomes:
1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

SUBJECT: Institute Level Elective: Cyber Security and Laws (CE-C ILOC-7017)
Course Outcomes:
1. Get to know natural as well as manmade disaster and their extent and possible effects on The economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure Associated with an emergency.
4. Get to know the simple dos and don'ts in such extreme events and act accordingly.

SUBJECT: Institute Level Elective: Energy Audit and Management (CE-C ILOC-7018)
Course Outcomes:
1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving Measures.

Final Year 8th Sem (CBCS)
SUBJECT: Design and Drawing of Reinforced Concrete Structures (CE-C 801)
Course Outcomes:
1. Design independently RCC structure by applying IS code provisions.
2. Design staircase, water tank and retaining wall.
3. Explain principles of PSC and calculate losses.
4. Draw and explain the structural detailing.
5. Explain response of structure during an earthquake and calculate design forces.

SUBJECT: Construction Management (CE-C 802)
Course Outcomes:

1. Understand & apply the knowledge of management functions like planning, scheduling, Executing & controlling the construction projects.
2. Prepare feasible project schedule by using various scheduling techniques.
3. Gain knowledge of managing various resources &recommend best method of allocating The resources to the project.
4. develop optimum relationship between time & cost for construction project
5. Implement quality & safety measures on construction sites during execution of civil Engineering projects.
6. Understand the importance of labour legislation

SUBJECT: Department Level Elective:
Advanced Design of Steel Structures (CE-C DLO8031)
Course Outcomes:
1. To perform the analysis and design of special steel structures
2. The will be able to analysis and design the gantry girder by limit state method.
3. They will be able to analysis and design steel chimney, lattice tower, tubular truss and Water tank
4. Students should able to independently design steel structures using relevant IS codes.

SUBJECT: Department Level Elective:
Industrial Waste Treatment (CE-C DLO8032)
Course Outcomes:
1. Understand the characteristics of industrial wastewater.
2. Identify sampling method and analyze industrial waste.
3. Design facilities for the processing and reclamation of industrial waste water.
4. Explain on-site treatment methods and solve Analyze and design wastewater treatment Systems. (Floatation, vacuum filtration, centrifugation, filter press and membrane filters)
5. Detailed on-site manufacturing processes and treatments of industrial waste water.
6. Analyze proposed development project plans for possible environmental effects and to Improve treated effluent quality to confirm standard prescribed by regulatory agencies.

SUBJECT: Department Level Elective: Pavement Design and Construction (CE-C DLO8033)
Course Outcomes:
1. Understand the structural actions involved in the pavement due to different types of load Acting thereon and the various methods of analysis of pavements.
2. Understand the applications of the analysis in the design of pavements using different Methods of pavement design.
3. Know the different types of distresses occurring in the existing pavements and carry out the Structural and functional evaluation of the pavements.
4. Apply the knowledge of evaluation in pre-empting the failure and to arrive upon the Methodology of the rehabilitation of pavements.
5. Understand the various aspects of the construction of concrete roads and low volume roads.

6. Understand the pavement management system and quality control and assurance criteria and Subsequently, its application in the highway construction.

SUBJECT: Department Level Elective: Bridge Engineering and Design (CE-C DLO8034)

Course Outcomes:
1. Select the suitable type of bridge according to the site condition.
2. Understand IRC loads, distribution of these loads on deck slab and among longitudinal Beams/girders of a bridge.
3. Design of culvert, balanced cantilever reinforced concrete Bridge, prestressed concrete Deck Slab Bridge, I-girdered and box girdered bridge, lattice girder railway bridge.
4. Understand different types of foundations, piers and abutments, their methods of Construction.
5. Understand various types of bearings and their suitability, erection of bridge Superstructure.

SUBJECT: Department Level Elective: Appraisal &Implementation of Infrastructure Projects (CE-C DLO8035)

Course Outcomes:
1. Classify the projects and describe the phases involved in project formulation.
2. Prepare detailed project report on the basis of various feasibility studies and SWOT Analysis.
3. Devise a project's development cycle and get acquainted with the different appraisals in The process of deciding the worthiness of a project.
4. Exhibit and apply the managerial skills and knowledge of financial aspects required During the implementation of projects.
5. Identify various sources for project finance.
6. Know the various agencies involved in project implementation as well as select the Method of project implementation which is best suited for a particular project.

SUBJECT: Department Level Elective: Soil Dynamics (CE-C DLO8036)

Course Outcomes:
1. Acquire the knowledge of concepts, principles and applications of soil under Dynamic loading.
2. Develop an ability to design with reference to code provisions and solve the Practical soil problems subjected to vibrations.
3. Provide an impetus to new developments in related dynamic topics.
4. Carry out field tests on soil to know the dynamic properties of soil.

5. Calculate the dynamic earth pressure on retaining walls.

SUBJECT: Department Level Elective: Applied Hydrology & Flood Control (CE-C DLO8037)

Course Outcomes:
1. Explain hydrologic cycle and various methods of Measurement of rainfall.
2. Calculate optimum number of rain gauge stations for average rainfall and missing rainfall Over catchment
3. Describe various methods of measurement of stream flow and to calculate abstraction losses Over the catchment
4. Develop rainfall runoff relationship and calculating runoff over catchment
5. Perform hydrologic and hydraulic routing

6. Derive the equations for the discharge of well for confined and unconfined aquifer.

SUBJECT: Institute Level Elective: Project Management (CE-C ILOC8021)

Course Outcomes:
1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them Strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference.

SUBJECT: Institute Level Elective: Finance Management (CE-C ILOC8022)

Course Outcomes:
1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

SUBJECT: Institute level Elective : Entrepreneurship Development and Management (CE-C ILOC8023)

Course Outcomes:
1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs.

SUBJECT: Institute level Elective: Human Resource Management (CE-C ILOC8024)

Course Outcomes:
1. Understand the concepts, aspects, techniques and practices of the human resource Management.
2. Understand the Human resource management (HRM) processes, functions, changes and Challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and Intergroup environment emerging as future stable engineers and managers.
5. SUBJECT: Intitute level Elective: Professional Ethics and CSR (CE-C ILOC8025)
6. Course Outcomes:
7. Understand rights and duties of business
8. Distinguish different aspects of corporate social responsibility
9. Demonstrate professional ethics
10. Understand legal aspects of corporate social responsibility.

SUBJECT: Institute level Elective: Research Methodology (CE-C ILOC8026)

Course Outcomes:
1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings.

Vishwaniketan's

Institute of Management Entrepreneurship and Engineering Technology

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Tal- Khalapur, Maharashtra 410203.
Phone: (02192) 274206/274207/274208/274210

SUBJECT: Institute level Elective: IPR & Patenting (CE-C ILOC8027)

Course Outcomes:

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting.

SUBJECT: Institute Level Elective: Digital Business Management (CE- C ILOC8028)

Course Outcomes:

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan.

SUBJECT: Institute level Elective : Environmental Management (CE- C ILOC8029)

Course Outcomes:

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Department of Electrical Engineering

Course Outcomes of Rev- 2019 University of Mumbai

('C' Scheme Choice Based Credit and Grading System)

Second Year

III SEMESTER ('C' Scheme Choice Based)

Course Code	Course Name	Course Outcomes

Vishwaniketan's

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EEC301	Engineering Mathematics-III	1. Apply the concept of Laplace transform to solve the real integrals in engineering problems. 2. Apply the concept of inverse Laplace transform of various functions in engineering problems. 3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems. 4. Find orthogonal trajectories and analytic function by using basic concepts of complex variables. 5. Illustrate the use of matrix algebra to solve the engineering problems. 6. Apply the concepts of vector calculus in real life problems.
EEC302	Electrical Circuit Analysis	1. Apply network theorems for the analysis of electrical circuits. 2. Obtain the transient and steady-state response of electrical circuits. 3. Develop and analyse transfer function model of system using two port network parameters. 4. Analyse time domain behaviour from pole zero plot. 5. Analyse electrical network using graph theory. 6. Analyse the effect of switching conditions on electrical networks using differential equations and Laplace Theorem.
EEC303	Fundamentals of Electrical Machines & Measurements	1. Illustrate the principle of energy conversion in single and double excited machines. 2. Understand and analyze the significance of the DC machines performance parameters. 3. Implement various starting methods and speed control methods for DC machines applications 4. Evaluate the working of various sensors, transducers and analog / digital instruments used in electrical and electronic measurements. 5. Analyze the use and performance of bridges used in electrical and electronic measurements. 6. Illustrate the need for extension of range of meters and calibration in instruments.
EEC304	Electrical Power System-I	1. Understand the power system and its components. 2. Categorize the ac transmission / distribution lines and understand the insulators. 3. Evaluate the parameters of different types of ac transmission / distribution lines. 4. Draw the PU reactance diagram of a power system for analysis. 5. Analyse the performance of transmission lines. 6. Study the performance parameters of electric cable and earthing.

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EEC305	Analog Electronics	1. Analyze the performance of various rectifiers and filter circuits. 2. Illustrate the use DC and AC parameters of BJT in analysis of amplifier circuits. 3. Apply the knowledge of MOSFET's DC/ AC parameters in analysis of amplifier and switching applications of MOSFET. 4. Understand the functioning of OP-AMP and design OP-AMP based circuits. 5. Illustrate the practical design aspect of regulated power supply circuits using linear regulators. 6. Understand applications of commonly used special semiconductor devices.
EEL301	Electrical Machines & Measurements Lab	1. Illustrate and analyze the performance of DC machines. 2. Demonstrate different speed control methods of DC motors. 3. Illustrate and analyze the working of various sensors, transducers and instruments used for measurement of the various physical parameters. 4. Demonstrate the use of bridges for measurements of passive electrical components. 5. Understand and analyse the working signal processing circuits used in measurements and instruments
EEL302	Electronics Lab-I	1. Identify the different types of semiconductor devices and demonstrate their applications in electronic circuits. 2. Analyse the performance of different types of rectifier with and without filter. 3. Determine the dc and ac parameters of various semiconductor devices. 4. Illustrate the frequency response of BJT/ MOSFET amplifier. 5. Understand the practical use of Op-amps in signal processing and waveform generators.
EEL303	Simulation Lab-I	1. Develop the skill to use the software packages to model and program electrical and electronics systems 2. Model different electrical and electronic systems and analyze the results 3. Articulate importance of software packages used for simulation in laboratory experimentation /research/industry by analyzing the simulation results. 4. Simulate electric machines/circuits for performance analysis.

EEL304	SBL-I: Applied Electrical Engineering Lab	1. Demonstrate the effective use of various electrical and electronic measuring lab equipments. 2. Identify various electrical LV/HV substation, supply equipments and their network connection 3. Identify and use different low voltage protective switchgears along with residential / industrial wiring practices. 4. Illustrate the understanding of Repair and maintenance of common electrical appliances. 5. Handle Electrical fire and shock hazards safety challenges in real practice.
EEM301	Mini Project – 1A	1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life long learning. 9. Demonstrate project management principles during project work.

Second Year
IV SEMESTER ('C' Scheme Choice Based)

Course Code	Course Name	Course Outcomes
EEC401	Engineering Mathematics-IV	1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals. 2. Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI. 3. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities. 4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems. 5. Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications. 6. Find the extremals of the functional using the concept of Calculus of variation.

EEC402	Electrical AC Machines-I	1. Illustrate working principle and performance of single phase transformer under different operating conditions 2. Understand working principle of autotransformer. 3. Analyze various types of connections and performance of three phase transformer under various conditions. 4. Demonstrate working principle and evaluate the performance of three phase induction motor under various operating conditions. 5. Exemplify various starting methods and speed control of three phase induction motor.
EEC403	Digital Electronics	1. Perform conversion of various number systems 2. Understand working of logic families and logic gates. 3. Design and implement combinational circuits. 4. Design and implement sequential circuits. 5. Understand the process of Analog to Digital conversion and Digital to Analog conversion. 6. Illustrate the use of PLDs to implement the given logical problem.
EEC404	Digital Electronics	1. Understand the basic operation and characteristics of various semi controllable and fully controllable devices 2. Analyse various single phase and three phase power converter circuits and understand their applications. 3. Analyse dc to dc converter circuits and their applications. 4. Identify and describe various auxiliary circuits and requirements in power electronics applications such as gate driver circuit, snubber circuits and heat sinks. 5. Apply the basic concepts to select devices and converters for various applications
EEC405	Electric and Hybrid Electric Vehicles	1. Identify and describe the history and evolvement of electric & hybrid electric vehicles. 2. Identify and describe the principles of various EV/HEVs drive train topologies. 3. Select electric propulsion system components for EV/HEV drives for the desirable performance and control. 4. Compare and evaluate various energy sources and energy storage components for EV/HEV. 5. Model, analyze and design EV/HEV drive train with energy management strategies. 6. Recognize the need to adapt and engage in operations EV/HEV for sustainable transportation system.
EEL401	Electrical AC Machines Lab I	1. Demonstrate the working principles and types of connections of 1φ and 3φ transformers. 2. Analyze the performance of 3φ transformer under various operating conditions. 3. Evaluate the performance of 3φ induction motor by carrying no load test , blocked rotor test and load test 4. Illustrate the operation of various type of 3φ induction motor starters.

		5. Illustrate different methods of speed control and braking of 3φ induction motors.
EEL402	Python Programming Lab	1. Describe the numbers, Math functions, Strings, List, Tuples and Dictionaries in Python 2. Express different Decision Making statements and Functions 3. Illustrate the skill of object oriented programming in Python to develop applications in electrical engineering 4. Understand different File handling operations 5. Understand the design of GUI Applications in Python and evaluate different database operations
EEL403	Electronics Lab II	1. Use various digital logic Gates, flip-flops and counters for various applications 2. Build, design and analyse sequential / combinational circuits. 3. Understand the operation various power electronics devices and circuits 4. Use power converters for various real life applications 5. Realize the implementation of digital interface with power electronics converters
EEL404	SBL-II : PCB Design and Fabrication Lab	1. Understand types of PCBs and various tools used for PCB design. 2. Identify various electrical/electronic components and their packages/ footprints. 3. Illustrate the use of PCB CAD tools and their features for the practical designs. 4. Design the schematic, board layout for simple, moderately complex and complex circuits. 5. Fabricate and assemble the PCBs for simple and moderately complex circuits.
	Mini Project – 1B	1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life long learning. 9. Demonstrate project management principles during project work.

Third Year
V SEMESTER ('C' Scheme Choice Based)

Course Code	Course Name	Course Outcomes
EEC501	Electrical AC Machines-II	1. To illustrate the working of synchronous generator 2. To determine the voltage regulation of synchronous generator by different methods 3. To analyze the parallel operation of synchronous generators. 4. To apply Blondel's two reaction theory and solve simple problems on salient pole synchronous machines. 5. To analyze the operation of synchronous motor. 6. To derive the basic machine relations in dq0 variables for a synchronous machine without considering damper winding.
EEC502	Electrical Power System-II	1. Understand and analyse unsymmetrical faults on transmission line 2. Analyse symmetrical component and construct sequence network 3. Analyse symmetrical faults on transmission lines. 4. Understand power system transients 5. Understand phenomenon of lightning and insulation coordination. 6. Understand concept of corona.
EEC503	Control System	1. Demonstrate an understanding of the fundamentals of (feedback) control systems. 2. Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems. 3. Express and solve system equations in state-variable form (state variable models). 4. Determine the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs. 5. Determine the (absolute) stability of a closed-loop control system
EEC504	Electromagnetic Field and Wave	1. Apply knowledge of mathematics and physics in electrical engineering field. 2. Analyze electrostatic fields 3. Apply and analyse magneto-static fields. 4. Analyze the effect of material medium on electric and magnetic fields. 5. Analyze and formulate time varying electric and magnetic fields. 6. Formulate wave equations for Electromagnetic wave propagation in different media.
EEDO5011	Renewable Energy Sources	1. Understand different types conventional energy sources and their reserves 2. Identify and analyse the process of power generation through solar thermal energy utilization 3. Identify and analyse the process of power generation through solar photovoltaic energy utilization 4. Identify and describe the various components and types of Wind Energy system 5. Identify and describe the basic operation and types of Fuel cell system 6. Understand different types of other non-conventional energy sources

EEDO5012	Advanced Power Electronics	1. Analyze and select dc to dc power electronic converter topology for energy conversion applications. 2. Apply the basic concepts of magnetics to design high frequency transformers and Inductors for dc to dc converter topologies. 3. Analyze resonant power electronic converter topologies for high frequency applications 4. Model and design controllers for the closed loop operation of dc to dc converters. 5. Apply the basic concepts of power electronics in the fields of AC and DC drives, power generation and energy conversion, industrial applications, extraction of energy from renewable sources.
EEDO5013	Advanced Measurements and Instrumentation	1. Classify, select and use various types of measurement sensors/ transducers and instrumentation system suitable for the given application 2. Classify and select proper measuring instrument for various electrical and non-electrical parameters measurements 3. Illustrate the principles and application of MEMS in various fields of engineering. 4. Understand the working of digital data acquisition system 5. Understand the role of virtual instrumentation in various application domains
EEDO5014	Analog and Digital Communication	1. Understand theory of noise and the various methods involved in modulation techniques 2. Interpret the concepts in analog communication and differentiate various analog modulation techniques. 3. Develop the concepts in digital communication and various digital modulation techniques 4. Apply and integrate various pulsed modulation in digital communication systems. 5. Conversant in proposing suitable error controlling and correction algorithms. 6. Understand and incorporate the basic knowledge of optical fiber communication and Satellite communication.
EEL501	Electrical AC Machines Lab-II	1. To analyze the operation of synchronous machines 2. To determine the voltage regulation of synchronous machines 3. To analyze the synchronization (or parallel operation) of synchronous machines 4. To determine the parameters of synchronous machines
EEL502	Simulation Lab-II	1. Develop the skill to use the software packages to model and program electrical and electronics systems 2. Model different electrical and electronic systems and analyze the results 3. Articulate importance of software packages used for simulation in laboratory experimentation /research/industry by analyzing the simulation results. 4. Simulate circuits for performance analysis.

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EEL503	Control System Lab	1. Illustrate the functioning of various components of control system. 2. Analyse the response of physical system for various inputs. 3. Analyze and interpret stability of the system through Root Locus, Bode plot and Nyquist plots 4. Execute time response analysis of a second order control system using MATLAB
EEL504	Professional Communication and Ethics-II	1. plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles. 2. strategize their personal and professional skills to build a professional image and meet the demands of the industry. 3. emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. 4. deliver persuasive and professional presentations. 5. develop creative thinking and interpersonal skills required for effective professional communication. 6. apply codes of ethical conduct, personal integrity and norms of organizational behaviour.
EEM501	Mini Project – 2A	1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/ simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning. 9. Demonstrate project management principles during project work

Third Year
VI SEMESTER ('C' Scheme Choice Based)

Course Code	Course Name	Course Outcomes
EEC601	Power System Protection & Switchgear	1. To select the appropriate switching/protecting device forsubstations. 2. To discriminate between the application of circuit breaker and fuses as a protective device. 3. To understand the basic concept of relay, types of relay and their applications in power system. 4. To select the specific protection required for different components of power system according to the type of fault. 5. To apply the specific protection provided for different types of transmission lines

EEC602	Microcontroller Applications	1. To analyse the difference between microprocessor and microcontroller based systems. 2. To write, debug and execute the software programs for internal peripheral devices of microcontroller. 3. To write, debug and execute the software programs for external peripheral devices for microcontroller based systems. 4. To design and implement the peripheral devices interfacing with microcontroller
EEC603	Control System Design	1. Define fundamental control system design specifications and basic principles of controller design 2. Understand the basic design of various compensators. 3. Design compensators using root locus techniques. 4. Design modern controllers based on the state space techniques, 5. Recognize the importance of observability and controllability for system design.
EEC604	Signals and Systems	1. Discriminate continuous and discrete time signals and systems. 2. Understand the transformation of discrete time signal to Z domain. 3. Analyse frequency response of systems using Z domain. 4. Design, implementation, analysis and comparison of digital filters for processing of discrete time signals
EEDO6011	Special Electrical Machine	1. To exemplify the working of Stepper motor and its control 2. To demonstrate the functioning of SRM motor and its control 3. To illustrate the working of BLDC motor and its control 4. To illustrate the operational features of PMSM motor and its control 5. To illustrate the operational features of Synchronous reluctance motor and its control 6. To illustrate the working of Linear motors
EEDO6012	Electric Traction	1. To illustrate the basics as well as the state of the art of electrical traction systems and subsystems. 2. To understand traction mechanics and different factors contributing to the traction. 3. To illustrate and analyse the performance of various traction motors and drives 4. To explain the traction power Supply arrangement and its protection aspects. 5. To understand the design requirements of the overhead equipments 6. To demonstrate the functioning of railway signaling system
EEDO6013	High Voltage Engineering	1. To know the fundamentals properties of the materials and their failure mechanisms to get appropriate and optimal design. 2. To explain and calculate the generation and measurement of High DC, AC and Impulse voltages and currents. 3. To understand testing of High voltage power apparatus. 4. To illustrate the major requirements in design of HV Laboratories

EEDO6014	Energy Storage	1. To illustrate the importance of energy storage systems in Power systems and other application domains 2. To illustrate the operational features of various energy storage technologies 3. To understand the principles and types of thermal, mechanical, electrochemical and electrical energy storage systems. 4. To compare and contrast different types of Energy storage systems 5. To illustrate the hybridization of various ES technology to improve the performance 6. To calculate the capacity of ES system for various application requirements,
EEL601	Power System Protection & Switchgear Lab	1. To understand the working principle of various protective devices like Circuit breakers, fuses, switches and contactors. 2. To understand the concept of various over current protection scheme and its applications in power system. 3. To understand different protection schemes of transformer and Induction motor. 4. To understand protection schemes of transmission line.
EEL602	Microcontroller Applications Lab	1. To write, debug and execute Assembly language based programs. 2. To write, debug and execute embedded language based programs. 3. To design and implement the interfacing of internal peripheral devices. 4. To design and implement the interfacing of external peripheral devices.
EEL603	Control System Design Lab	1. Implement various types of compensators and control algorithms using simulation platforms 2. Apply root-locus & Bode Plot techniques to analyze and design control systems. 3. Able to design digital controllers, assess their design through the constraint specifications
EEL604	SBL-III: Industrial Automation Lab	1. To comprehend with various components and subsystems used in industrial automation 2. To understand the integration of components and sub-systems. 3. To interface the microcontroller / PLC with external devices/ sensors/ actuators. 4. To interface the microcontroller / PLC with control circuits. 5. To design /implement / integrate such systems for any given applications

EEM601	Mini Project – 2 B	1. Identify problems based on societal /research needs. 2. Apply Knowledge and skill to solve societal problems in a group. 3. Develop interpersonal skills to work as member of a group or leader. 4. Draw the proper inferences from available results through theoretical/ experimental/ simulations. 5. Analyse the impact of solutions in societal and environmental context for sustainable development. 6. Use standard norms of engineering practices 7. Excel in written and oral communication. 8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning. 9. Demonstrate project management principles during project work

Course Outcomes of Rev- 2016 University of Mumbai
(Choice Based Credit and Grading System)
Final Year
VII SEMESTER (Choice Based Credit and Grading System)

Course Code	Course Name	Course Outcomes
EEC701	Power System - III	1. Analyse different methods of load flow problem. 2. Understand the economic system operation. 3. Understand the automatic frequency and voltage control strategies for single and two area case 4. Analyse dynamics of power systems and various methods to improve stability of systems 5. Understand the concept of voltage stability and use different methods to analyse it. 6. Understand importance of power system security and interchange of power
EEC702	Drives and Control	1. To understand the dynamics of electrical drive. 2. To understand the motor power rating calculation for a specific application for reliable operation. 3. To understand the modes of operation and close loop control of electrical drive. 4. To analyse the speed control of DC drives in an energy efficient manner using power electronics. 5. To analyse the speed control of induction motor drive using various methods. 6. To learn the advance control techniques for AC drives.
EEC703	High Voltage Direct Current Transmission	1. Identify significance of dc over ac transmission systems, types of HVDC link, Components of HVDC system and applications. 2. Analyse multi-pulse converters. 3. Understand the basic control of HVDC system and its limitation, features and implementation. 4. Understand converter firing control schemes for starting and stopping of HVDC link. 5. Understand and analyse faults and protection of HVDC system. 6. Understand harmonics, their causes, effects and use of different filters.

EEDLO7031	High Voltage Engineering	1. To know the fundamentals properties of the materials and their failure mechanisms to get appropriate and optimal design. 2. Of testing of different dielectric materials and the major requirements for setting up of HV Laboratories.
EEDLO7032	Electric Vehicle Technology	1. To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future. 2. To identify and describe the principles of various EV/HEVs drive train topologies along with their power flow control and fuel efficiency estimation. 3. To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control. 4. To compare and evaluate various energy sources and energy storage components for EV and HEV applications. 5. To model, analyze and design EV/HEV drive train with energy management strategies. 6. To recognize the need to adapt and engage in operations EV/HEV with the absolute technological change in the transportation system for sustainable future.
EEDLO7033	Industrial Controller	1. Understand significance of P, I and D controlled techniques, disturbance rejection and reference tracking of PI and PD controllers and fuzzy logic implementation. 2. Understand the various manual tuning methods of PID controllers and their design. 3. Understand the common notation of industrial PID and digital PID and learn various issues in implementation of industrial PID. 4. Ability to represent various components of PLC in a block diagram and understand the different type of I/O devices that can be connected to PLC. 5. Understand the instruction set of PLC and analyse the given problem statement to develop a ladder logic for it. 6. Analyse the various types of I/O modules of PLC
EEDLO7034	Power Quality	1. Identify various power quality issues, its causes and effects. 2. Identify and analyse the harmonics created due to nonlinear load. 3. Learn and analyse the power factor compensation for linear and nonlinear loads. 4. Understand various power quality mitigation techniques. 5. Identify various power quality issues in distributed generation system. 6. Understand power quality measuring equipment and monitoring standards.
ILO7011	Product Lifecycle Management	1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. 2. Illustrate various approaches and techniques for designing and developing products. 3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. 4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plan
ILO7012	Reliability Engineering	1. Understand and apply the concept of Probability to engineering problems 2. Apply various reliability concepts to calculate different reliability parameters 3. Estimate the system reliability of simple and complex systems 4. Carry out a Failure Mode Effect and Criticality Analysis

ILO7013	Management Information System	1. Explain how information systems Transform Business 2. Identify the impact information systems have on an organization 3. Describe IT infrastructure and its components and its current trends 4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making 5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses
ILO7014	Design of Experiments	1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action. 2. Apply the methods taught to real life situations. 3. Plan, analyze, and interpret the results of experiments
ILO7015	Operation Research	1. Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand. 2. Understand the relationship between a linear program and its dual, including strong duality and complementary slackness. 3. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. 4. Solve specialized linear programming problems like the transportation and assignment problems. 5. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems. 6. Understand the applications of, basic methods for, and challenges in integer programming 7. Model a dynamic system as a queuing model and compute important performance measures
ILO7016	Cyber Security and Laws	1. Understand the concept of cyber crime and its effect on outside world • Interpret and apply IT law in various legal issues 2. Distinguish different aspects of cyber law 3. Apply Information Security Standards compliance during software design and development
ILO7017	Disaster Management and Mitigation Measures	1. Understand natural as well as manmade disaster and their extent and possible effects on the economy. 2. Planning of national importance structures based upon the previous history. 3. Understand government policies, acts and various organizational structure associated with an emergency. 4. Know the simple do's and don'ts in such extreme events and act accordingly
ILO7018	Energy Audit and Management	1. Identify and describe present state of energy security and its importance. 2. Identify and describe the basic principles and methodologies adopted in energy audit of an utility. 3. Describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. Describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. Analyse the data collected during performance evaluation and recommend energy saving measures 6. Understand energy conservation in buildings.

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ILO7019	Development Engineering	1. Apply knowledge for Rural Development 2. Apply knowledge for Management Issues. 3. Apply knowledge for Initiatives and Strategies. 4. Develop acumen for higher education and research. 5. Master the art of working in group of different nature. 6. Develop confidence to take up rural project activities independently.
EEL701	Simulation Lab - III	1. To impart knowledge on coding and simulation of HVDCT systems for its analysis. 2. To impart knowledge on coding and simulation of power system for its analysis. 3. To impart knowledge on coding and simulation of electrical drives for its analysis. 4. To impart knowledge on coding and simulation of converter and rectifier
EEL702	Drives and Control Lab	1. To analyse the dynamic performance of electrical ac drives. 2. To analyse the dynamic performance of electrical dc drives. 3. To analyse the dynamics of braking of electrical ac motors 4. To analyse the dynamics of braking of electrical dc motors
EEL703	Project-I	1. Do literature survey/industrial visit and identify the problem • Apply basic engineering fundamental in the domain of practical applications 2. Cultivate the habit of working in a team 3. Attempt a problem solution in a right approach 4. Correlate the theoretical and experimental/simulations results and draw the proper inferences 5. Prepare report as per the standard guidelines.

VIII SEMESTER (Choice Based Credit and Grading System)

Course Code	Course Name	Course Outcomes
EEC801	Design, Management and Auditing of Electrical Systems	1. Understand the necessity of power system forecasting and different power system techniques 2. Understand the different power system planning tools 3. Calculate reliability in terms of basic reliability indices 4. Analyse generation capacity models 5. Understand operating reserve techniques 6. Understand Composite generation and transmission system
EEC802	Flexible AC Transmission System	1. Illustrate the aspects of flexible ac transmission system over conventional ac transmission system 2. Analyze the concept of load compensation. 3. Categorize the static shunt and series compensation for transmission line. 4. Outline the concept of voltage and phase angle regulators. 5. Understand unified power flow controllers using circuit diagram and phasors

EEDLO8041	Illumination Engineering	1. Identify and describe the various laws of illumination, lighting parameters, light sources, luminaries and their Photometric characteristics. 2. Identify and describe various LED lighting components / subsystems, thermal management and lifetime studies. 3. Formulate and design an Interior Lighting system through standards, design considerations and calculation for different application areas. 4. Formulate and design an Exterior Lighting system through standards, design considerations and calculation for different application areas. 5. Identify and describe different Lighting Control schemes. 6. Identify and describe Solid-State Lighting technology, it's applications in Lighting for health and safety and solar powered schemes.
EEDLO8042	Smart Grid	1. To identify and describe the history and evolvement Smart Grid, its features /functions and Barriers 2. To classify and describe the principles of various Smart Grid enabling Technologies. 3. To evaluate and compare applications of Smart Measurement and Monitoring Technologies. 4. To identify and describe the role Microgrids and Distributed Energy Resources in evolvement of Smartgrid 5. To Identify and describe the importance of various communication technology used for Smart Grid. 6. To assess the Power Quality issues and its Management in Smart Grid..
EEDLO8043	Power System Modeling and Control	1. To understand the basic concept of stability and its types 2. To evaluate the models of synchronous machine, induction machine, excitation system and load. 3. To analyse the dynamic stability of power system.
EEDLO8044	Power System Planning and Reliability	1. Learn plans, line diagram for design project. 2. Select the size and specification of power distribution transformer. 3. Design switchgear and cable system for distribution system. 4. Analyse energy monitoring and targeting 5. Understand concept of energy audit 6. Understand energy efficient technologies used improve energy efficiency

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ILO8021	Project Management	1. Apply selection criteria and select an appropriate project from different options. 2. Write work break down structure for a project and develop a schedule based on it. 3. Identify opportunities and threats to the project and decide an approach to deal with them strategically. 4. Use Earned value technique and determine & predict status of the project. 5. Capture lessons learned during project phases and document them for future reference
ILO8022	Finance Management	1. Understand Indian finance system and corporate finance 2. Take investment, finance as well as dividend decisions
ILO8023	Entrepreneurship Development and Management	1. Understand the concept of business plan and ownerships 2. Interpret key regulations and legal aspects of entrepreneurship in India 3. Understand government policies for entrepreneurs
ILO8024	Human Resource Management	1. Understand the concept of business plan and ownerships 2. Interpret key regulations and legal aspects of entrepreneurship in India 3. Understand government policies for entrepreneurs
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	1. Understand rights and duties of business 2. Distinguish different aspects of corporate social responsibility 3. Demonstrate professional ethics 4. Understand legal aspects of corporate social responsibility
ILO8026	Research Methodology	1. Prepare a preliminary research design for projects in their subject matter areas 2. Accurately collect, analyze and report data 3. Present complex data or situations clearly 4. Review and analyze research findings
ILO8027	IPR and Patenting	1. understand Intellectual Property assets 2. assist individuals and organizations in capacity building 3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting
ILO8028	Digital Business Management	1. Identify drivers of digital business 2. Illustrate various approaches and techniques for E-business and management 3. Prepare E-business plan
ILO8029	Environmental Management	1. Understand the concept of environmental management 2. Understand ecosystem and interdependence, food chain etc. 3. Understand and interpret environment related legislations

EEL801	Simulation Lab - IV	1. Analyze the transmission line performance with and without FACTS controllers using simulations. 2. Analyze the operation of various electrical systems using simulation.
EEL802	Electrical System Design Lab	1. To design basic electrical network theorem-based Circuit 2. To design and Implementation of Single /Multi output Power supply 3. To design and Implementation of Buck/Boost/ Buck-boost dc-dc Converter.
EEL803	Project-II	1. Do literature survey/industrial visit and identify the problem • Apply basic engineering fundamental in the domain of practical applications 2. Cultivate the habit of working in a team 3. Attempt a problem solution in a right approach 4. Correlate the theoretical and experimental/simulations results and draw the proper inferences 5. Prepare report as per the standard guidelines.

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Department of Electronics and Telecommunication
Second Year R_19
III rd Sem (CBCS)

	Subject : Engineering Mathematics-III (ECC301)
Sr. No.	
1	Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2	Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3	Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4	Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
5	Use matrix algebra to solve the engineering problems.
6	Apply the concepts of vector calculus in real life problems.
	Subject : Electronic Devices & Circuits (ECC302)
1	Know functionality and applications of various electronic devices.
2	Explain working of various electronics devices with the help of V-I characteristics
3	Derive expressions for performance parameters of BJT and MOSFET circuits.
4	Evaluate performance of Electronic circuits (BJT and MOSFET based).
5	Select appropriate circuit for given application.
6	Design electronic circuit (BJT, MOSFET based) circuits for given specifications
	Subject :Digital System Design (ECC303)
1	Understand types of digital logic, digital circuits and logic families.
2	Analyze, design and implement combinational logic circuits.
3	Analyze, design and implement sequential logic circuits.
4	Develop a digital logic and apply it to solve real life problems
5	Classify different types of memories and PLDs.
6	Simulate and implement basic combinational and sequential circuits using VHDL/Verilog.
	Subject :Network Theory (ECC304)
1	Apply their knowledge in analyzing Circuits by using network theorems
2	Apply the time and frequency method of analysis
3	Evaluate circuit using graph theory.
4	Find the various parameters of two port network.
5	Apply network topology for analyzing the circuit.
6	Synthesize the network using passive elements.
	Subject :Electronic Instrumentation & Control Systems +-\(ECC305)
1	Identify various sensors, transducers and their brief performance specification.
2	Understand the principle of working of various transducer used to measure temperature, displacement, level, pressure and their application in industry
3	Determine the models of physical systems in forms suitable for use in the analysis and design of control systems

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4	Obtain the transfer functions for a given Control system.
5	Understand the analysis of systems in time domain and frequency domain
6	Predict stability of given system using appropriate criteria.

Subject :Electronic Devices & Circuits Lab(ECL301)

1	Know various equipment's, electronics devices and components, and measuring instruments used to perform laboratory work.
2	Students will be able to explain functionality of various equipment's, electronics devices and components and neasu6 instruments used to perform laboratory work.
3	Students will be able connect various equipment's, devices, components and measuring devices using bread board as per the circuit diagram for experiment to be performed.
4	Students will able to perform experiment to gather appropriate data.
5	Students will able to analyze data obtained from experiment to relate theory with experiment results.
6	Students will able to prepare laboratory report (Journal) to summarize the outcome each experiment.

Subject :Digital System Design Lab(ECL302)

1	Identify various Digital ICs and basic building blocks of digital system design
2	Design and implement combinational circuits like adder, subtractor, multiplexer, code converters etc.
3	Identify and understand working of various types of flip flops and their inter conversions.
4	Design and implement basic sequential circuits such as counters, registers etc.
5	Acquire basic knowledge of VHDL/Verilog basic programming.

Subject :Electronic Instrumentation & Control Systems Lab.(ECL303)

1	Plot and validate the performance characteristics of transducers
2	Validate the characteristics of various temperature, pressure and level transducers.
3	Plot frequency response of first-order electrical system.
4	Plot time response of second-order electrical system and calculate the steady-state error.
5	Validate the effect of damping factor on the response of second order system
6	Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system

Subject :Skill Lab: C++ and Java Programming.(ECL304)

1	Describe the basic principles of OOP.
2	Design and apply OOP principles for effective programming
3	Develop programming applications using OOP language.
4	Implement different programming applications using packaging.
5	Analyze the strength of OOP.
6	Percept the Utility and applicability of OOP.

Subject :Mini Project 1A.(ECM301)

1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader
4	Draw the proper inferences from available results through theoretical/experimental/simulations.
5	Analyse the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.

8	Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9	Demonstrate project management principles during project work.
	**Subject :Mini Project 1A: Analog & Digital Circuit Design based Projects(ECM301)**
1	Create the electronics circuit for particular application/experiment.
2	Design and simulate the circuits by putting together the analog and digital components
3	Learn the technique of soldering and circuit implementation on general purpose printed circuit board (GPP).
4	Realize the PCB design process and gain up-to-date knowledge of PCB design software.
5	Utilize the basic electronic tools and equipment's (like DMM, CRO, DSO etc.)
6	Analysis of hardware fault (Fault detection and correction)
	Second Year R_19 III rd Sem (CBCS)
	**Subject :Engineering Mathematics-IV.(ECC401)**
1	Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals
2	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3	Apply the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
4	Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
5	Use the concept of Quadratic forms and Singular value decomposition which are very useful tools in various Engineering applications.
6	Find the extremals of the functional using the concept of Calculus of variation.
	**Subject :Microcontrollers.(ECC402)**
1	Understand Computer and its memory System.
2	Understand the detailed architecture of 8051 and ARM7 Core.
3	Write programs for 8051 microcontrollers.
4	Design an applications using microcontroller.
	**Subject :Linear Integrated Circuits.(ECC403)**
1	Outline and classify all types of integrated circuits.
2	Understand the fundamentals and areas of applications for the integrated circuits.
3	Develop the ability to design practical circuits that perform the desired operations.
4	Understand the differences between theoretical & practical results in integrated circuits.
5	Identify the appropriate integrated circuit modules for designing engineering application
	**Subject :Signals and Systems.(ECC404)**
1	Classify and Analyze different types of signals and systems
2	Analyze continuous time LTI signals and systems in transform domain
3	Analyze and realize discrete time LTI signals and systems in transform domain
4	Represent signals using Fourier Series and Analyze the systems using the Fourier Transform.
5	Demonstrate the concepts learnt in Signals and systems Course using the modern engineering tools.
	**Subject :Principles of Communication Engineering.(ECC405)**
1	Understand the basic components and types of noises in communication system
2	Analyze the concepts of amplitude modulation and demodulation
3	Analyze the concepts of angle modulation and demodulation.
4	Compare the performance of AM and FM receivers.
5	Describe analog and digital pulse modulation techniques

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6	Illustrate the principles of multiplexing and demultiplexing techniques.
Subject :Microcontrollers Lab.(ECL401)	
1	Understand different development tools required to develop microcontroller based systems.
2	Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations
3	Write assembly language programs for general purpose I/O, Timers & Interrupts.
4	Interface & write programs for Input and Output devices
5	Develop microcontroller based Applications
Subject: Linear Integrated Circuits Lab..(ECL402)	
1	Understand the differences between theoretical, practical and simulated results in integrated circuits.
2	Apply the knowledge to do simple mathematical operations
3	Apply knowledge of op-amp, timer and voltage regulator ICs to design simple applications.
Subject: Principles of Communication Engineering Lab...(ECL403)	
1	Analyze analog modulation techniques
2	Analyze the waveforms of Radio receivers
3	Implement analog pulse modulation and demodulation circuits
4	Demonstrate digital pulse modulation and demodulation techniques
5	Verify the concepts of TDM and FDM
Subject: Skill Lab: Python Programming..(ECL404)	
1	Describe syntax and semantics in Python
2	Illustrate different file handling operations
3	Interpret object oriented programming in Python
4	Design GUI Applications in Python
5	Express proficiency in the handling Python libraries for data science
6	Develop machine learning applications using Python University
Subject :Mini Project 1B(ECM401)	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations
5	Analyse the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Subject :Mini-Project1B: Arduino & Raspberry Pi based Projects(ECM401)	
1	Write basic codes for the Arduino board using the IDE for utilizing the onboard resources
2	Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task.
3	Design Arduino based projects for a given problem
4	Write code using python language using IDE for utilizing the onboard resources
5	Apply the knowledge of interfacing different devices to raspberry Pi board to accomplish a given task
6	Design Raspberry Pi based projects for a given problem.

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Course outcomes R2016 University of Mumbai
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Third Year R_19		
V th Sem (CBCS)		

Subject :Digital communication (ECC501)		
1	Apply the concepts of information theory in source coding.	
2	Compare different error control systems and apply various error detection codes.	
3	Analyze different error correction codes.	
4	Compare various baseband transmission methods for digital signals.	
5	Evaluate the performance of optimum baseband detection in the presence of white noise	
6	Compare the performances of different digital modulation techniques	
Subject :Discrete-Time Signal Processing(ECC502)		
1	Recall the system representations and understand the relation between different transforms.	
2	Understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis	
3	Design digital IIR and FIR filters to satisfy the given specifications and evaluate the frequency response and pole zero representations to choose a particular filter for the given application.	
4	Interpret the different realization structures of Digital IIR and FIR filters.	
5	Analyze the impact of hardware limitations on the performance of digital filters	
6	Apply signal processing concepts, algorithms in applications related to the field of biomedical and audio signal processing	
Subject :Discrete-Digital VLSI (ECC503)		
1	Know various tools and processes used in VLSI Design	
2	Explain working of various CMOS combinational and sequential circuits used in VLSI Design.	
3	Derive expressions for performance parameters of basic building blocks like CMOS inverter.	
4	Relate performance parameters with design parameters of VLSI circuits.	
5	Select suitable circuit and design style for given application.	
6	Design and realize various combinational and sequential circuits for given specifications.	
Subject :Random Signal Analysis(ECC504)		
1	Apply theory of probability in identifying and solving relevant problems.	
2	Differentiate continuous and discrete random variables and their distributions.	
3	Analyze mean, variance, and distribution function of random variables and functions of random variables.	
4	Define a random process, determine the type of the process and find the response of LTI system for WSS process.	
5	Explain linear regression algorithms and apply for predictive applications.	
Subject :Digital and IP TV Engineering(ECCDLO 5011)		
1	To provide in depth knowledge about Digital Television system	
2	To familiarize students' various types of advanced types of Video cameras and Displays	
3	To introduce the students to different television standards and applications	
4	Acquaintance with HDTV and 3D TV system	
5	To familiarize the students to IPTV, Its architecture, Protocols and hardware	
6	To Introduce students to IP delivery networks, threats and mitigation	
Subject :Data Compression and Cryptography(ECCDLO 5012)		
1	Apply various compression techniques for text and understand image compression and its standards.	
2	Select suitable compression techniques for specified lossless and lossy audio and video applications.	

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3	Compare between symmetric and asymmetric cryptography and also describe different symmetric cryptographic techniques and standards
4	Apply number theory concepts to solve the cryptographic problems.
5	Analyze different public key cryptography algorithms and also describe methods that provide the goals for integrity, confidentiality and authentication.
6	Describe system security facilities designed to protect a computer system from security threats and also appreciate ethical issues related to system security.

Subject :IT Infra & Security(ECCDLO 5013)

1	Understand IT Infrastructure and its Management.
2	Understand the concept of Information securities.
3	Summarize the concepts of vulnerabilities, attacks and protection mechanisms.
4	Analyze software vulnerabilities and attacks on databases and operating systems.
5	Explain the need for security protocols in the context of wireless communication.
6	Analyze the different attacks on Open Web Applications and Web services.

Subject :Data Structure & Algorithm(ECCDLO 5014)

1	Compare functions using asymptotic analysis and describe the relative merits of worst-, average-, and best-case analysis
2	Apply various operations on Stack and Queue.
3	Ability to demonstrate the operation of Linked list.
4	Ability to demonstrate and apply Trees & Graph data structures.
5	Become familiar with various Sorting and Searching Algorithms and their performance characteristics.
6	Describe the hash function and concepts of collision and its resolution methods University

Subject :Sensor Technology(ECCDLO 5015)

1	Understand the transduction principal of various sensors.
2	Select sensors suitable for required application
3	Analyze wireless sensing techniques
4	Design the data acquisition system
5	Identify signal conditioning method for particular application
6	Create an application using various sensor technologies

Subject :Digital Communication Lab(ECCDLO 501)

1	Compare various source coding schemes
2	Design and implement different error detection codes
3	Design and implement different error correction codes
4	Compare various line coding techniques
5	Illustrate the impulse response of a matched filter for optimum detection
6	Demonstrate various digital modulation techniques

Subject :Discrete-Time Signal Processing Laboratory(ECL 502)

1	Perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results.
2	Demonstrate their ability towards interpreting and performing frequency analysis of different discrete time sequences and systems.
3	Design and implement the FIR and IIR Filters for given specifications.
4	Implement and analyse applications related to the field of biomedical signal processing and audio signal processing.

Subject :Digital VLSI Lab(ECL 503)

1	Write spice code for given combinational and sequential CMOS circuits.

2	Perform various analysis like operating point, dc, transient etc of given CMSO circuits.
3	Evaluate performance of given CMOS circuits.
4	Draw layout of given CMOS circuit and also able extract various parasitic using open source layout tool like Magic
5	Design, simulate, and verify CMOS circuit for given specifications.
	**Subject :Professional Communication & Ethics-II(ECL 504)**
1	Write spice code for given combinational and sequential CMOS circuits.
2	Perform various analysis like operating point, dc, transient etc of given CMSO circuits.
3	Evaluate performance of given CMOS circuits.
4	Draw layout of given CMOS circuit and also able extract various parasitic using open source layout tool like Magic
5	Design, simulate, and verify CMOS circuit for given specifications
	**Subject :Mini Project 2A:Embedded System Project(ECM 501)**
1	Understand the embedded systems with design metrics.
2	Understand microcontrollers and programming in Embedded C.
3	Implementation of Embedded systems with different sensors and peripherals as IoT.
4	Implementation of Embedded systems with different communication protocols as IoT.
5	Analyze concepts of Real time operating systems.
6	Design embedded system applications using sensors, peripherals and RTOS

Third Year R_19
VI th Sem (CBCS)

	**Subject :Electromagnetics and Antenna(ECC 601)**
1	Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations
2	Students will be able to apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3	Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4	Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.
	**Subject :Computer Communication Networks(ECC 602)**
1	Analyze network topologies, hardware devices, addressing schemes and the protocol stacks
2	Compare various transmission media and broadband technologies
3	Analyze the flow control, error control and the medium access control techniques
4	Judge network layer addressing and routing schemes
5	Analyze connection oriented and connectionless services
6	Apply the knowledge of application layer protocols
	**Subject :Digital Image Processing and Machine Vision(ECC 603)**
1	Understand fundamentals of image processing and machine vision
2	Enhance the quality of image using spatial and frequency domain techniques for image enhancement
3	Learn image morphology and restoration techniques
4	Learn image segmentation techniques based on principle of discontinuity and similarity using various algorithms
5	Represent boundaries and shapes using standard techniques
6	Classify the object using different classification methods
	**Subject :Artificial Neural Networks and Fuzzy Logic(ECC 604)**

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1	Comprehend the concepts of biological neurons and artificial neurons
2	Analyze the feed-forward and feedback neural networks and their learning algorithms.
3	Comprehend the neural network training and design concepts
4	Build a simple CNN model and apply in image classification
5	Analyze the application of neural networks and fuzzy logic to real world problems.
Subject :Mixed Signal VLSI(ECCDLO 6011)	
1	Know operation of the various building blocks of analog and mixed signal VLSI circuits
2	Demonstrate the understanding of various building blocks and their use in design of analog and mixed signal circuits
3	Derive expression for various performance measures of analog and mixed signal circuits in terms of parameters of various building blocks used to build the circuit.
4	Analyze and relate performance of analog and mixed signal VLSI circuits in terms of design parameters.
5	Evaluate and select appropriate circuit/configuration for given application.
6	Design analog and mixed signal VLSI circuits for given application.
Subject :Computer Organisation and Architecture(ECCDLO 6012)	
1	Describe Computer system along with I/O operations and performance measures.
2	Demonstrate data representation and different arithmetic algorithm for solving ALU operations
3	Categorize memory organization and identify the function of each element of memory hierarchy
4	Demonstrate control unit operations.
5	Articulate design issues in the development of Multiprocessor organization & architecture
Subject :Digital Forensic(ECCDLO 6013)	
1	Study the various cybercrimes and its prevention methods.
2	Discuss the phases of Digital Forensics and methodology to handle the computer security incident
3	Understand the process of collection, analysis and recovery of the digital evidence.
4	Explore various tools to perform the investigation of the crime scenario
5	Investigate the process of monitoring and analysis of computer network traffic for network investigation.
6	Discuss the legal issues associated with the cyber laws.
Subject :Database Management System(ECCDLO 6014)	
1	Describe the fundamentals of database systems, different data models and design issues in database.
2	Understand the basics model of relational Algebra, calculus, transaction management, concurrency control , database security and privacy
3	Design ER diagram, relational schemas, apply concepts of normalization to relational database design.
4	Implement views, triggers and querying the database using SQL.
Subject :IoT and Industry 4.0(ECCDLO 6015)	
1	Discuss case studies and use cases of IoT design.
2	Illustrate various protocols of web connectivity.
3	Understand and use tools for data management and analytics in IoT.
4	Explain various frameworks for industry 4.0 standards
5	Prepare case studies on applications of IIOT.
6	Understand advanced concepts and applications of industry 4.0
Subject :Radar Engineering(ECCDLO 6016)	
1	Explain generalized concept of RADAR
2	Solve problems using radar equations
3	Describe different types of radar for specific application

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| 4 | Explain concept of tracking radar. |
| 5 | Plot the RADAR target from given specification |

Subject :Electromagnetics and Antenna Lab(ECL 601)	
1	Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations
2	Students will be able to apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3	Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4	Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

Subject :Computer Communication Network Laboratory(ECL 602)	
1	Design a small or medium sized computer network including media types, end devices, and interconnecting devices that meets a customer's specific needs.
2	Perform configurations on routers and Ethernet switches.
3	Demonstrate knowledge of programming for network communications.
4	Simulate computer networks and analyze the simulation results.
5	Troubleshoot connectivity problems in a host occurring at multiple layers of the OSI model.
6	Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator

Subject :Image Processing and Machine Vision Laboratory(ECL 603)	
1	perform enhancement of digital images in spatial and frequency domain
2	perform edge detection and morphological operations on digital images
3	classify patterns using standard Machine vision classification techniques like SVM
4	apply theoretical knowledge in image processing and machine vision to practical case studies

Subject :Skill Laboratory :Linux &Networking & Server Configuration (ECL 604)	
1	Install Linux using different platform and execute standard Linux commands.
2	Describe the basic knowledge of Linux Operating System
3	Deploy the system administrative functionality
4	Solve the problems using shell script programming
5	Develop network based applications
6	Apply the Linux commands using programming skill to deploy different servers like ftp, telnet etc.

Subject :Mini Project2B: FPGA based Project (ECM 601)	
1	Understand various FPGA families and method of FPGA synthesis and implementation
2	Learn the working of basic EDA tools like Xilinx, Modelsim, cadence etc.
3	Able to program, simulate and synthesize circuits in Verilog HDL.
4	Learn the technique of interfacing of LED, switches and seven segment with FPGA.
5	Learn the project documentation, designing and handling techniques
6	Analysis of FPAG fault detection and verification principles

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Final Year R_16
VII th Sem (CBCS)

	Subject :Microwave Engineering (ECC 701)
1	Characterize devices at higher frequencies.
2	Design and analyze microwave circuits.
3	Design and analyze amplifiers and oscillators at microwave frequencies.
4	Demonstrate skills of planning, design and deployment of microwave networks.

	Subject :Mobile Communication System(ECC 702)
1	Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems
2	Classify different types of propagation models and analyze the link budget.
3	Illustrate the fundamentals and system architecture of GSM, 2.5G and IS-95.
4	Apply the concepts of 3G technologies of UMTS and CDMA 2000
5	Elaborate the principles of 3GPP LTE.
6	Identify the emerging technologies for upcoming mobile communication systems

	Subject :Optical Communication(ECC 702)
1	List, write and explain fundamentals and transmission characteristics of optical fiber Communication.
2	List, write and explain principles and characteristics of various sources ,detectors and various fiber optic components
3	Calculate parameters for optical link budgeting and analyze the link

	Neural networks & Fuzzy Logic (ECCDLO7031)
1	Comprehend the concepts of biological neurons and artificial neurons
2	Analyze the feed-forward and feedback neural networks and their learning algorithms.
3	Calculate Comprehend the neural network training and design concepts
4	Analyze the application of neural networks to nonlinear real world problem
5	Comprehend the concept of fuzziness involved in various systems, fuzzy set theory and fuzzy logic
6	Apply fuzzy logic to real world problems.

	Big Data Analytics (ECCDLO7032)
1	Understand the key issues in big data management.
2	Acquire fundamental enabling techniques using tools in big data analytics.
3	Achieve adequate perspectives of big data analytics in various applications like sensor, recommender systems, social media applications etc.

	Internet Communication Engineering (ECCDLO7033)
1	Explain the operation of the components of a router including, DHCP, NAT/PAT, Routing function, Switching function.
2	Describe how DNS works in the global Internet including caching and root servers.
3	Understand the current state-of-the-art developments in Internet technologies for multimedia communications.
4	Understand the security protocol and services In the Internet
5	Appreciate the principles used in designing multimedia protocols, and so understand why standard protocols are designed the way that they are.
6	Understand the system design principles of multimedia communications systems
7	Solve problems and design simple networked multimedia systems.

	CMOS Mixed Signal VLSI (ECCDLO7034)

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1	Analyze and design single stage MOS Amplifiers.
2	Analyze and design Operational Amplifiers.
3	Analyze and design data converter circuits.
4	Identify design requirements of analog and mixed signal circuits
5	Analyze and design CMOS based switched capacitor circuits
6	Understand Oscillators and Phase Locked Loops.
	**Embedded Systems (ECCDLO7035)**
1	Understand the detailed processor design techniques and methods of communication.
2	Study the in-depth program modelling concepts.
3	Study the concepts of Real time operating systems and write programs
4	Design embedded system applications using RTOS
	**Product Lifecycle Management (ECCILO7031)**
1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2	illustrate various approaches and techniques for designing and developing products.
3	Apply product engineering guidelines / thumb rules in designing products for molding, machining ,sheet metal working etc.
4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant
	**Reliability Engineering (ECCILO7012)**
1	Understand and apply the concept of Probability to engineering problems
2	Apply various reliability concepts to calculate different reliability parameters
3	Estimate the system reliability of simple and complex systems
4	Carry out a Failure Mode Effect and Criticality Analysis
	**Management Information System (ECCILO7013)**
1	Explain how information systems Transform Business
2	Identify the impact information systems have on an organization
3	Describe IT infrastructure and its components and its current trends
4	Understand the principal tools and technologies for accessing information from databases to
5	improve business performance and decision making
6	Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses
	**Design of experiments(ECCILO7014)**
1	Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2	Apply the methods taught to real life situations
3	Plan, analyze, and interpret the results of experiments
	**Operations Research(ECCILO7015)**
1	Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2	Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3	Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4	Understand the applications of integer programming and a queuing model and compute

	important performance measures
Cyber Security and Laws(ECCILO7016)	
1	Understand the concept of cybercrime and its effect on outside world
2	Interpret and apply IT law in various legal issues
3	Distinguish different aspects of cyber law
4	Apply Information Security Standards compliance during software design and development
Disaster Management and Mitigation Measures (ECCILO7017)	
1	Get to know natural as well as manmade disaster and their extent and possible effects on the economy
2	Plan of national importance structures based upon the previous history.
3	Get acquainted with government policies, acts and various organizational structure associated with an emergency.
5	Get to know the simple do's and don'ts in such extreme events and act accordingly.
Energy Audit and Management(ECCILO7018)	
1	To identify and describe present state of energy security and its importance
2	To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3	To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities
4	To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5	To analyze the data collected during performance evaluation and recommend energy saving measures
Development Engineering(ECCILO7019)	
1	Apply knowledge for Rural Development.
2	Apply knowledge for Management Issues.
3	Apply knowledge for Initiatives and Strategies
4	Develop acumen for higher education and research.
5	Master the art of working in group of different nature.
6	Develop confidence to take up rural project activities independently
Final Year R_16 **VIII th Sem (CBCS)**	
RF Design (ECC801)	
1	Design impedance matching networks and passive RF filters.
2	Design and appraise RF amplifiers and oscillators.
3	Analyze EMI and EMC in RF circuits.
Wireless Networks (ECC802)	
1	Explain the working of different wireless technologies like bluetooth and zigbee.
2	Understand the working of wireless LAN, PAN & MAN
3	Analyze the different types of Wireless Networks like LAN,PAN & MAN
4	Comprehend the working of Femtocells
Optical Networks (ECCDLO8041)	
1	Identify the issues related to signal degradation and multiplexing.
2	Explore concepts of designing and operating principles of modern optical communication systems and networks.
3	Apply the knowledge developed in-class to contemporary optical fiber communication research and industrial areas.

	Advanced Digital Signal Processing(ECCDLO8042)
1	Demonstrate an understanding of Multirate sampling and its mechanism.
2	Study and apply the techniques of power spectrum estimation and wavelet theory for various applications.
3	Implement adaptive filters for given applications.
4	Apply signal processing tools to Biomedical and Telecommunication Applications

	Satellite Communication(ECCDLO8043)
1	Explain basics of satellite communication, space segment and earth segment
2	Understand different satellite orbits and orbital parameters
3	Explain and analyze link budget of satellite signal for proper communication
4	Understand various applications of satellite communications

	Network Management in Telecommunication(ECCDLO8044)
1	Explain the need for interoperable network management & analyze the trends and development of the Telecommunications Network Management.
2	Demonstrate broad knowledge of fundamental principles and technical standards underlying.
3	Describe the concepts and architecture behind standards based network management associated with SNMP and CMIP
4	Apply basic of telecommunication, networking and information technologies and architect and implement networked informative systems.
5	Continuously improve their technology knowledge and communication skills.

	Project Management(ECCILO8021)
1	Apply selection criteria and select an appropriate project from different options.
2	Write work break down structure for a project and develop a schedule based on it.
3	Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4	Use Earned value technique and determine & predict status of the project.
5	Capture lessons learned during project phases and document them for future reference

	Finance Management(ECCILO 8022)
1	Understand Indian finance system and corporate finance
2	Take investment, finance as well as dividend decisions

	Entrepreneurship Development and Management(ECCILO 8023)
1	Understand the concept of business plan and ownerships
2	Interpret key regulations and legal aspects of entrepreneurship in India
3	Understand government policies for entrepreneurs

	Human Resource Management(ECCILO 8024)
1	Understand the concepts, aspects, techniques and practices of the human resource management.
2	Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3	Gain knowledge about the latest developments and trends in HRM.
4	Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

	Professional Ethics and Corporate Social Responsibility (CSR)(ECCILO 8025)
1	Understand rights and duties of business
2	Distinguish different aspects of corporate social responsibility
3	Demonstrate professional ethics

4	Understand legal aspects of corporate social responsibility
Research Methodology(ECCILO 8026)	
1	Prepare a preliminary research design for projects in their subject matter areas
2	Accurately collect, analyze and report data
3	Present complex data or situations clearly
4	Review and analyze research findings
IPR and Patenting(ECCILO 8027)	
1	Understand Intellectual Property assets
2	Assist individuals and organizations in capacity building
3	Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting
Digital Business Management(ECCILO 8028)	
1	Identify drivers of digital business
2	Illustrate various approaches and techniques for E-business and management
3	Prepare E-business plan
Environmental Management(ECCILO 8029)	
1	Understand the concept of environmental management
2	Understand ecosystem and interdependence, food chain etc.
3	Understand and interpret environment related legislations

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Department of Computer Engineering

Choice Based Credit and Grading System R-19 University of Mumbai Syllabus

Semester: III

Subject Code: CSC301   **Subject: Engineering Mathematics-III**

Course Outcomes:

On successful completion, of course, learner/student will be able to:

1. Understand the concept of Laplace transform and its application to solve the real integralsin engineering problems.
2. Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3. Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.
4. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic functions.
5. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.
6. Understand the concepts of probability and expectation for getting the spread of the dataand distribution of probabilities.

Subject Code: CSC302   **Subject: Discrete Structures and Graph Theory**
Course Outcomes:
On successful completion, of course, learner/student will be able to:

1. Understand the notion of mathematical thinking, mathematical proofs and to apply themin problem solving.
2. Ability to reason logically.
3. Ability to understand relations, functions, Diagraph and Lattice.
4. Ability to understand and apply concepts of graph theory in solving real world problems.
5. Understand use of groups and codes in Encoding-Decoding
6. Analyze a complex computing problem and apply principles of discrete mathematics to identify solutions

Subject Code: CSC303   **Subject: Data Structure**
Course Outcomes:

1. Students will be able to implement Linear and Non-Linear data structures.
2. Students will be able to handle various operations like searching, insertion, deletion andtraversals on various data structures.
3. Students will be able to explain various data structures, related terminologies and its types.
4. Students will be able to choose appropriate data structure and apply it to solve problems invarious domains.
5. Students will be able to analyze and Implement appropriate searching techniques for a givenproblem.
6. Students will be able to demonstrate the ability to analyze, design, apply and use datastructures to solve engineering problems and evaluate their solutions.

Subject Code: CSC304   Subject: Digital Logic & Computer Organization and Architecture

Course Outcomes:
1. To learn different number systems and basic structure of computer system.
2. To demonstrate the arithmetic algorithms.
3. To understand the basic concepts of digital components and processor organization.
4. To understand the generation of control signals of computer.
5. To demonstrate the memory organization.
6. To describe the concepts of parallel processing and different Buses.

Subject Code: CSC305   Subject Computer Graphics
Course Outcomes:
At the end of the course, the students should be able to
1. Describe the basic concepts of Computer Graphics.
2. Demonstrate various algorithms for basic graphics primitives.
3. Apply 2-D geometric transformations on graphical objects.
4. Use various Clipping algorithms on graphical objects
5. Explore 3-D geometric transformations, curve representation techniques and projections methods.
6. Explain visible surface detection techniques and Animation

Subject Code: CSL301   Subject: Data Structures Lab
Course Outcomes:
1. Students will be able to implement linear data structures & be able to handle operations likeinsertion, deletion, searching and traversing on them.
2. Students will be able to implement nonlinear data structures & be able to handle operationslike insertion, deletion, searching and traversing on them
3. Students will be able to choose appropriate data structure and apply it in various problems
4. Students will be able to select appropriate searching techniques for given problems.

Subject Code: CSL302   Subject: Digital Logic & Computer Organization and Architecture Lab
Course Outcomes:
1. To understand the basics of digital components

2. Design the basic building blocks of a computer: ALU, registers, CPU and memory
3. To recognize the importance of digital systems in computer architecture
4. To implement various algorithms for arithmetic operations.

Subject Code: CSL303   Subject: Computer Graphics Lab
Course Outcomes:
At the end of the course, the students should be able to
1. Implement various output and filled area primitive algorithms
2. Apply transformation, projection and clipping algorithms on graphical objects.
3. Perform curve and fractal generation methods.
4. Develop a Graphical application/Animation based on learned concept

Subject Code: CSL304   Subject: Skill based Lab Course: Object Oriented Programming with Java
Course Outcomes:
At the end of the course, the students should be able to
1. To apply fundamental programming constructs.
2. To illustrate the concept of packages, classes and objects.
3. To elaborate the concept of strings, arrays and vectors.
4. To implement the concept of inheritance and interfaces.
5. To implement the concept of exception handling and multithreading.
6. To develop GUI based application.

Subject Code: CSM301   Subject: Mini Project A
Course Outcomes:
Learner will be able to…
1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences experimental/simulations. From available results throughtheoretical/
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9. Demonstrate project management principles during project work.

Choice Based Credit and Grading System R-19 University of Mumbai Syllabus

Semester: IV

Subject Code: CSC401   Subject: Engineering Mathematics-IV
Course Outcomes:
1. Apply the concepts of eigenvalues and eigenvectors in engineering problems.
2. Use the concepts of Complex Integration for evaluating integrals, computing residues &evaluate various contour integrals.
3. Apply the concept of Z- transformation and inverse in engineering problems.
4. Use the concept of probability distribution and sampling theory to engineering problems.
5. Apply the concept of Linear Programming Problems to optimization.
6. Solve Non-Linear Programming Problems for optimization of engineering problems.

Subject Code: CSC402   Subject: Analysis of Algorithms
Course Outcomes:
1. Analyze the running time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer strategy.
3. Describe, apply and analyze the complexity of greedy strategy.
4. Describe, apply and analyze the complexity of dynamic programming strategy.
5. Explain and apply backtracking, branch and bound.
6. Explain and apply string matching techniques.

Subject Code: CSC403   Subject: Database Management System
Course Outcomes:
1. Recognize the need of database management system
2. Design ER and EER diagram for real life applications
3. Construct relational model and write relational algebra queries.
4. Formulate SQL queries
5. Apply the concept of normalization to relational database design.

6. Describe the concept of transaction, concurrency and recovery.

Subject Code: CSC404   Subject: Operating System
Course Outcomes:
1. Understand the objectives, functions and structure of OS
2. Analyze the concept of process management and evaluate performance of process scheduling algorithms.
3. Understand and apply the concepts of synchronization and deadlocks
4. Evaluate performance of Memory allocation and replacement policies
5. Understand the concepts of file management.
6. Apply concepts of I/O management and analyze techniques of disk scheduling.

Subject Code: CSC405   Subject: Microprocessor
Course Outcomes:
1. Describe core concepts of 8086 microprocessor.
2. Interpret the instructions of 8086 and write assembly and Mixed language programs.
3. Identify the specifications of peripheral chip.
4. Design 8086 based system using memory and peripheral chips.
5. Appraise the architecture of advanced processors
6. Understand hyperthreading technology

Subject Code: CSL401   Subject: Analysis of Algorithms Lab
Course Outcomes:
1. Implement the algorithms using different approaches.
2. Analyze the complexities of various algorithms.
3. Compare the complexity of the algorithms for specific problem.

Subject Code: CSL402   Subject: Database Management system Lab
Course Outcomes:

1. Design ER /EER diagram and convert to relational model for the realworld application.
2. Apply DDL, DML, DCL and TCL commands
3. Write simple and complex queries
4. UsePL / SQL Constructs.
5. Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Subject Code: CSL403   Subject: Operating System Lab
Course Outcomes:
1. Demonstrate basic Operating system Commands, Shell scripts, System Calls and API wrtLinux
2. Implement various process scheduling algorithms and evaluate their performance.
3. Implement and analyze concepts of synchronization and deadlocks.
4. Implement various Memory Management techniques and evaluate their performance.
5. Implement and analyze concepts of virtual memory.
6. Demonstrate and analyze concepts of file management and I/O management techniques.

Subject Code: CSL404   Subject: Microprocessor Lab

Course Outcomes:

1. Use appropriate instructions to program microprocessor to perform various task
2. Develop the program in assembly/ mixed language for Intel 8086 processor
3. Demonstrate the execution and debugging of assembly/ mixed language program

Subject Code: CSL405   Subject: Skill Base Lab Course: Python Programming
Course Outcomes:
1. To understand basic concepts in python.
2. To explore contents of files, directories and text processing with python
3. To develop program for data structure using built in functions in python.
4. To explore django web framework for developing python-based web application.
5. To understand Multithreading concepts using python.

Subject Code: CSM401   Subject: Mini Project B
Course Outcomes:
1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences experimental/simulations. from   available   results through theoretical/
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9. Demonstrate project management principles during project work.

Choice Based Credit and Grading System R-16 University of Mumbai Syllabus
Semester : VI

Subject Code: CSC501   Subject: Theoretical Computer Science

Course Outcomes:

At the end of the course, the students will be able to
1. Understand concepts of   Theoretical Computer Science, difference and equivalence
2. of DFA and NFA , languages described by finite automata and regular expressions.
3. Design Context free grammer, pushdown automata to recognize the language.
4. Develop an understanding of computation through Turing Machine.
5. Acquire fundamental understanding of decidability and undesirability.

Subject Code: CSC502   Subject: Software Engineering

Course Outcomes:

On successful completion of course, learners will be able to:
1. Identify requirements & assess the process models.
2. Plan, schedule and track the progress of the projects.
3. Design the software projects.
4. Do testing of software project.
5. Identify risks, manage the change to assure quality in software projects.

Subject Code: CSC503   Subject: Computer Network
Course Outcomes:
On successful completion of course, learner will be able to
1. Demonstrate the concepts of data communication at physical layer and compare ISO - OSI
2. model with TCP/IP model.
3. Explore different design issues at data link layer.
4. Design the network using IP addressing and sub netting / supernetting schemes.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer

Subject Code: CSC504   Subject: Data Warehousing and Mining
Course Outcomes:
At the end of the course, the student will be able to

1. Understand data warehouse fundamentals and design data warehouse with dimensional modelling and apply OLAP operations.
2. Understand data mining principles and perform Data preprocessing and Visualization.
3. Identify appropriate data mining algorithms to solve real world problems.
4. Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
5. Describe complex information and social networks with respect to web mining.

Subject Code: CSDLO5011   Subject: Probabilistic Graphical Models
Course Outcomes:

On successful completion of course, learner will be able to

1. Understand basic concepts of probabilistic graphical modelling.

2. Model and extract inference from various graphical models like Bayesian Networks, Markov Models
3. Perform learning and take actions and decisions using probabilistic graphical models
4. Represent real world problems using graphical models; design inference algorithms; and learnthe structure of the graphical model from data.
5. Design real life applications using probabilistic graphical models.

Subject Code: CSDLO5012 Subject: Internet Programming

Course Outcomes:

On successful completion of course, learner will be able to
1. Implement interactive web page(s) using HTML and CSS.
2. Design a responsive web site using JavaScript and demonstrate database connectivity using
3. JDBC
4. Demonstrate Rich Internet Application using Ajax and demonstrate and differentiate various
5. Web Extensions
6. Demonstrate web application using Reactive Js

Subject Code: CSDLO5013 Subject: Advance Database Management System
Course Outcomes:

On successful completion of course, learner will be able to

1. Design distributed database using the various techniques for query processing
2. Measure query cost and perform distributed transaction management
3. Organize the data using XML and JSON database for better interoperability
4. Compare different types of NoSQL databases
5. Formulate NoSQL queries using Mongodb

6. Describe various trends in advance databases through temporal, graph based and spatial based databases

Subject Code: CSL501 Subject: Software Engineering Lab
Course Outcomes:

On successful completion of laboratory experiments, learners will be able to :

1. Identify requirements and apply software process model to selected case study.
2. Develop architectural models for the selected case study.
3. Use computer-aided software engineering (CASE) tools.

Subject Code: CSL502 Subject: Computer Network Lab
Course Outcomes:
On successful completion of laboratory experiments, learners will be able to :
1. Design and setup networking environment in Linux.

2. Use Network tools and simulators such as NS2, Wireshark etc. to explore networking
3. algorithms and protocols.

4. Implement programs using core programming APIs for understanding networking concepts.

Subject Code: CSL503   **Subject: Data Warehousing and Mining Lab**

Course Outcomes:

On successful completion of laboratory experiments, learners will be able to :

1. Design data warehouse and perform various OLAP operations.
2. Implement data mining algorithms like classification.
3. Implement clustering algorithms on a given set of data sample.
4. Implement Association rule mining & web mining algorithm.

Subject Code: CSL504   **Subject: Professional Communication & Ethics II**

Course Outcomes:

On successful completion of laboratory experiments, learners will be able to :

1. Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional
    a. communication.
6. Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Subject Code: CSM501   Subject: Mini Project 2A

Course Outcomes:
On successful completion of laboratory experiments, learners will be able to :
1. Identify societal/research/innovation/entrepreneurship problems through appropriate
2. literature surveys

3. Identify Methodology for solving above problem and apply engineering knowledge and
4. skills to solve it

5. Validate, Verify the results using test cases/benchmark data/theoretical/
6. inferences/experiments/simulations

7. Analyze and evaluate the impact of solution/product/research/innovation
8. /entrepreneurship towards societal/environmental/sustainable development

Subject Code: CSC601   **Subject: System Programming and Compiler Construction**

Course Outcomes:

On successful completion of laboratory experiments, learners will be able to :

1. Identify the relevance of different system programs.
2. Explain various data structures used for assembler and microprocessor design.

3. Distinguish between different loaders and linkers and their contribution in developing efficient user applications.

4. Understand fundamentals of compiler design and identify the relationships among different phases of the compiler.

Subject Code: CSC602   **Subject: Cryptography & System Security**

Course Outcomes:

1. Understand system security goals and concepts, classical encryption techniques and acquire
2. fundamental knowledge on the concepts of modular arithmetic and number theory

3. Understand, compare and apply different encryption and decryption techniques to solve
4. problems related to confidentiality and authentication

5. Apply different message digest and digital signature algorithms to verify integrity and
6. achieve authentication and design secure applications

7. Understand network security basics, analyse different attacks on networks and evaluate the
8. performance of firewalls and security protocols like SSL, IPSec, and PGP
9. Analyse and apply system security concept to recognize malicious code

Subject Code: CSC603   **Subject: Mobile Computing**

Course Outcomes:

On successful completion of course, learner will be able to
1. To identify basic concepts and principles in computing, cellular architecture.
2. To describe the components and functioning of mobile networking.
3. To classify variety of security techniques in mobile network.
4. To apply the concepts of WLAN for local as well as remote applications.
5. To describe Long Term Evolution (LTE) architecture and its interfaces.

Subject Code: CSC604   **Subject: Artificial Intelligence**

Course Outcomes:

At the end of the course, the students will be able to
1 Ability to develop a basic understanding of AI building blocks presented in intelligent agents.

2 Ability to choose an appropriate problem solving method and knowledge representation technique.
3 Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
4 Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
5 Ability to design and develop AI applications in real world scenarios.

Subject Code: CSDLO6011   Subject: Digital Signal & Image Processing

Course Outcomes:

On the completion of the course, learners will be able to:
1 Understand the concepts of IoT and the Things in IoT.
2 Emphasize core IoT functional Stack and understand application protocols for IoT.
3 Apply IoT knowledge to key industries that IoT is revolutionizing.
4 Examines various IoT hardware items and software platforms used in projects.

Subject Code: CSDLO6012 Subject: Internet of Things

Course Outcomes:

On successful completion of course, learners will be able to:
1 Understand the concept of DT Signal and DT Systems
2 Classify and analyze discrete time signals and systems
3 Implement Digital Signal Transform techniques DFT and FFT
4 Use the enhancement techniques for digital Image Processing
5 Apply image segmentation techniques

Subject Code: CSDLO6013 Subject: Quantitative Analysis

Course Outcomes:

1 Recognize the need of Statistics and Quantitative Analysis
2 Apply the data collection and the sampling methods.
3 Analyze using concepts of Regression, Multiple Linear Regression
4 Formulate Statistical inference drawing methods.
5 Apply Testing of hypotheses

Subject Code: CSL601   Subject: System Programming and Compiler Construction Lab

Course Outcomes:

At the end of the course, the students will be able to
1 Generate machine code by implementing two pass assemblers.
2 Implement Two pass macro processor.
3 Parse the given input string by constructing Top down/Bottom-up parser.
4 Identify and Validate tokens for given high level language and Implement synthesis phase of compiler.
5 Explore LEX & YACC tools.

Subject Code: CSL602   **Subject: Cryptography & System Security Lab**

Course Outcomes:

At the end of the course, the students will be able to

1. apply the knowledge of symmetric and asymmetric cryptography to implement simple ciphers.
2. explore the different network reconnaissance tools to gather information about networks.
3. explore and use tools like sniffers, port scanners and other related tools for analysing packets in a Network.
4. set up firewalls and intrusion detection systems using open-source technologies and to explore email security.
5. explore various attacks like buffer-overflow and web application attack.

Subject Code: CSL603   **Subject: Mobile Computing Lab**

Course Outcomes:

At the end of the course, the students will be able to
1. develop and demonstrate mobile applications using various tools
2. articulate the knowledge of GSM, CDMA & Bluetooth technologies and demonstrate it.
3. Students will able to carry out simulation of frequency reuse, hidden/exposed   terminal problem
4. implement security algorithms for mobile communication network
5. demonstrate simulation and compare the performance of Wireless LAN

Subject Code: CSL604   **Subject: Artificial Intelligence Lab**

Course Outcomes:

At the end of the course, the students will be able to

1. Identify languages and technologies for Artificial Intelligence
2. Understand and implement uninformed and informed searching techniques for real world problems.
3. Create a knowledge base using any AI language.
4. Design and implement expert systems for real world problems.

Subject Code: CSL605   **Subject: Cloud Computing**

Course Outcomes:

At the end of the course, the students will be able to
1. Implement different types of virtualization techniques.
2. Analyze various cloud computing service models and implement them to solve the given problems.
3. Design and develop real world web applications and deploy them on commercial cloud(s).
4. Explain major security issues in the cloud and mechanisms to address them.
5. Explore various commercially available cloud services and recommend the appropriate one for the given application.
6. Implement the concept of containerization

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Subject Code: **CSM601**   **Subject: Mini Project 2B**

Course Outcomes:

1   Identify   societal/research/innovation/entrepreneurship problems through appropriate literature surveys
    Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
2   Validate,Verify the   results   using   test   cases/benchmark   data/theoretical/ inferences/experiments/simulations
    Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurshiptowards societal/environmental/sustainable development
3   Use standard norms of engineering practices and project management principles during project work
4   Communicate through technical report writing and oral presentation.
5   The work may result in research/white paper/ article/blog writing and publication
6   The work may result in business plan for entrepreneurship product created
7   The work may result in patent filing.
    a.   Gain technical competency towards participation in Competitions, Hackathons, etc.
    b.   Demonstrate capabilities of self-learning, leading to lifelong learning.
    c.   Develop interpersonal skills to work as a member of a group or as leader

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Semester : VII

Subject Code: CSC701   Subject Name: Digital Signal & Image Processing

Course outcomes: On successful completion of the course learner will be able to:
1. Apply the concept of DT Signal and DT Systems.
2. Classify and analyze discrete time signals and systems
3. Implement Digital Signal Transform techniques DFT and FFT.
4. Use the enhancement techniques for digital Image Processing
5. Differentiate between the advantages and disadvantages of different edge detection techniques
6. Develop small projects of 1-D and 2-D Digital Signal Processing.

Subject Code: CSC702   Subject Name: Mobile Communication & Computing

Course outcomes: On successful completion of course, learner will be able:

1. To identify basic concepts and principles in mobile communication & computing, cellular architecture.
2. To describe the components and functioning of mobile networking.
3. To classify variety of security techniques in mobile network.
4. To apply the concepts of WLAN for local as well as remote applications.
5. To describe and apply the concepts of mobility management
6. To describe Long Term Evolution (LTE) architecture and its interfaces.

Subject Code: CSC703   Subject Name: Artificial Intelligence & Soft Computing
Course Outcomes: Students should be able to –
1 Identify the various characteristics of Artificial Intelligence and Soft Computing techniques.
2 Choose an appropriate problem-solving method for an agent to find a sequence of actions to reach the goal state.
3 Analyse the strength and weakness of AI approaches to knowledge representation, reasoning and planning.
4 Construct supervised and unsupervised ANN for real world applications.
5 Design fuzzy controller system.
6 Apply Hybrid approach for expert system design.

Subject Code: CSDLO7031   Subject Name: Advanced System Security and Digital Forensics
Course Outcomes: At the end of the course learner will able to
1. Understand cyber-attacks and apply access control policies and control mechanisms.
2. Identify malicious code and targeted malicious code.
3. Detect and counter threats to web applications.
4. Understand the vulnerabilities of Wi-Fi networks and explore different measures to secure wireless protocols, WLAN and VPN networks.
5. Understand the ethical and legal issues associated with cybercrimes and be able to mitigate impact of crimes with suitable policies.
6. Use different forensic tools to acquire and duplicate data from compromised systems and analyse the same

Lab Outcome: Learner will able to
1. Analyze static code and program vulnerabilities using open source tools.
2. Explore and analyze network vulnerabilities using open source tools.

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3. Explore and analyze different security tools to detect web application and browser vulnerabilities.
4. Explore and analyze different tools to secure wireless networks and routers, and mobile devices and perform penetration testing, and analyze its impact.
5. Understand and implement AAA using RADIUS and TACACS.
6. Explore various forensics tools in Kali Linux and use them to acquire, duplicate and analyze data and recover deleted data

Subject Code: CSDLO7032   Subject Name: Big Data Analytics
Course Outcomes: Learner will be able to…
1. Understand the key issues in big data management and its associated applications for business decisions and strategy.
1. Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Mapreduce and NoSQL in big data analytics.
2. Collect, manage, store, query and analyze various forms of Big Data.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
5. Solve Complex real-world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Subject Code: CSDLO7033   Subject Name: Robotics
Course outcomes: On successful completion of course, learner will be able to:
1. Describe typical robot and its characteristics.
2. Analyse kinematics parameters of robotic manipulator.
3. Identify actuators, sensors and control of a robot for different applications.
4. Design task plan and motion for a robot.
5. Apply Robotics to solve day to day problems using vision algorithms.
6. Use robot programming languages and acquire skills to program robots

Subject Code: ILO 7011   Subject Name: Product Life Cycle Management
Outcomes: Learner will be able to…
1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Subject Code: ILO 7012   Subject Name: Reliability Engineering

Outcomes: Learner will be able to…
1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems

4. Carry out a Failure Mode Effect and Criticality Analysis

Subject Code: ILO 7013   Subject Name: ILO 7013
Outcomes: Learner will be able to…
1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Subject Code: ILO 7014   Subject Name: Design of Experiments
Outcomes: Learner will be able to…
1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Subject Code: ILO 7015   Subject Name: Operations Research
Outcomes: Learner will be able to…
1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Subject Code: ILO 7016   Subject Name: Cyber Security and Laws
Outcomes: Learner will be able to…
1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Subject Code: ILO 7017   Subject Name: Disaster Management and Mitigation Measures

Outcomes: Learner will be able to…
1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Subject Code: ILO 7018 Subject Name: Energy Audit and Management

Outcomes: Learner will be able to…
1. To identify and describe present state of energy security and its importance.

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2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Subject Code: ILO7019   Subject Name: Development Engineering

Outcomes: Learner will be able to…
1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Lab Code: Lab Name: Digital Signal and Image Processing Lab

Lab Outcome: The learner will be able to
1. Sample and reconstruct the signal.
2. Implement and apply operations like Convolution, Correlation, DFT and FFT on DT signals
3. Implement spatial domain Image enhancement techniques.
4. Implement Edge detection techniques using first order derivative filters.

Lab Code: CSL702   Lab Name: Mobile Application Development Lab

Lab Outcome:

1. To develop and demonstrate mobile applications using various tools
2. Students will articulate the knowledge of GSM, CDMA & Bluetooth technologies and demonstrate it.
3. Students will able to carry out simulation of frequency reuse , hidden terminal problem
4. To develop security algorithms for mobile communication network
5. To demonstrate simulation and compare the performance of Wireless LAN
6. To implement and demonstrate mobile node discovery and route maintains.

Lab Code: CSL703   Lab Name: Artificial Intelligence & Soft Computing Lab

Lab Outcomes: Learner will be able to
1 To realize the basic techniques to build intelligent systems
2 To create knowledge base and apply appropriate search techniques used in problem solving.
3 Apply the supervised/unsupervised learning algorithm.
4 Design fuzzy controller system

Lab Code: CSL703   Lab Name: Computational Lab-I

Lab Outcome: After successful completion of this course student will be able to:
1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach

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Semester: VIII

Subject Code: CSC801   Subject Name: Human Machine Interaction
Course Outcomes: At the end of the course, the students will be able to -
1. Identify User Interface (UI) design principles.
2. Analysis of effective user-friendly interfaces.
3. Apply Interactive Design process in real world applications.
4. Evaluate UI design and justify.
5. Create application for social and technical task.

Subject Code: CSC802   Subject Name: Distributed Computing
Course outcomes: On successful completion of course, learner will be able to:
1. Demonstrate knowledge of the basic elements and concepts related to distributed system technologies;
2. Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3. Analyze the various techniques used for clock synchronization and mutual exclusion
4. Demonstrate the concepts of Resource and Process management and synchronization algorithms
5. Demonstrate the concepts of Consistency and Replication Management
6. Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications.

Subject Code: DLO8011   Subject Name: High Performance Computing
Course Outcomes: Learner will be able to1. Memorize parallel processing approaches
2. Describe different parallel processing platforms involved in achieving High Performance Computing.
3. Discuss different design issues in parallel programming
4. Develop efficient and high-performance parallel programming
5. Learn parallel programming using message passing paradigm using open-source APIs.

Subject Code: DLO8012   Subject Name: Natural Language Processing
Course outcomes: On successful completion of course, learner should:
1. Have a broad understanding of the field of natural language processing.
2. Have a sense of the capabilities and limitations of current natural language technologies,
3. Be able to model linguistic phenomena with formal grammars.
4. Be able to Design, implement and test algorithms for NLP problems
5. Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP
6. Be able to apply NLP techniques to design real world NLP applications such as machine translation, text
categorization, text summarization, information extraction...etc

Subject Code: DLO8013   Subject Name: Adhoc Wireless Networks
Course outcomes: On successful completion of course, learner will be able to:
1. Identify the characteristics and features of Adhoc Networks.

2. Understand the concepts & be able to design MAC protocols for Ad Hoc networks
3. Implement protocols / Carry out simulation of routing protocols of Adhoc Networks
4. Interpret the flow control in transport layer of Ad Hoc Networks
5. Analyze security principles for routing of Ad Hoc Networks
6. Utilize the concepts of Adhoc Networks in VANETs

Lab Outcome:
1. Explore the knowledge of NS2 and NS3 by installing it and make it ready
2. Shall synthesize a simulation and evaluate the performance of WLAN 802.11 and Bluetooth
3. Students will able to analyze and implement MAC & Network layer protocols using open source and synthesis as well as evaluate its performance
4. Implement Transport layer protocols / Carry out simulation of routing protocols of Adhoc Networks
5. Describe and interpret the use security routines and evaluate its performance
6. Explore and understand the capability of SUMO and MOVE as well as Nessi by installing it and analyze it by applying on various scenarios

Subject Code: ILO 8021   Subject Name: Project Management
Outcomes: Learner will be able to…
1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Subject Code: ILO 8022   Subject Name: Finance Management
Outcomes: Learner will be able to…
1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Subject Code: ILO8023 Subject Name: Entrepreneurship Development and Management
Outcomes: Learner will be able to…
1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Subject Code: ILO8024   Subject Name: Human Resource Management
Outcomes: Learner will be able to…
1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers

Subject Code: ILO8025   Subject Name: Professional Ethics and Corporate Social Responsibility (CSR)
Outcomes: Learner will be able to…
1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics

4. Understand legal aspects of corporate social responsibility

Subject Code: ILO8026   Subject Name: Research Methodology
Outcomes: Learner will be able to…
1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Subject Code: ILO8027   Subject Name: IPR and Patenting
Outcomes: Learner will be able to…
1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Subject Code: ILO 8028   Subject Name: Digital Business Management
Outcomes: The learner will be able to ….
1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Subject Code: ILO8029   Subject Name: Environmental Management
Outcomes: Learner will be able to…
1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Subject Code: CSL801   Subject Name: Human Machine Interactions Lab
Lab Outcome:
1: To design user centric interfaces.
2: To design innovative and user-friendly interfaces.
3: To apply HMI in their day-to-day activities.
4: To criticize existing interface designs, and improve them.
5: To Design application for social Task.
6: To Design application for Technical Tasks

Subject Code: CSL802   Subject Name: Distributed Computing Lab
Lab Outcome:
1. Develop, test and debug RPC/RMI based client-server programs.
2. Implement the main underlying components of distributed systems (such as IPC, name resolution, file systems etc.)
3. Implement various techniques of synchronization.
4. Design and implement application programs on distributed systems.

Subject Code: CSL803   Subject Name: Cloud Computing Lab
Lab Outcomes: On completion of the course learners will be able to
1. Adapt different types of virtualizations and increase resource utilization.
2. Build a private cloud using open-source technologies.
3. Analyze security issues on cloud.

4. Develop real world web applications and deploy on commercial cloud.
5. Demonstrate various service models.

Subject Code: CSL804   **Subject Name: Computational Lab II**
Lab Outcome: After successful completion of this course student will be able to:
1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach

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Department of AIML Engineering

Course Outcomes R- 2019 University of Mumbai

Syllabus (choice Based Credit Grading System)

SECOND YEAR Sem- III (CBCS)

Subject: Engineering Mathematics III(Course Code- CSC 301)

- Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.

- Understand the concept of inverse Laplace transform of various functions and its

  applications in engineering problems.

- Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems

- Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic functions.

- Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.

- Understand the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.

Subject: Discrete Structures and Graph Theory (Course Code- CSC 302)
- Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
- Ability to reason logically.
- Ability to understand relations, functions, Diagraph and Lattice.
- Ability to understand and apply concepts of graph theory in solving real world problems.
- Understand use of groups and codes in Encoding-Decoding
- Analyze a complex computing problem and apply principles of discrete mathematics to identify solutions

Subject: Data Structure (Course Code- CSC 303)

- Students will be able to implement Linear and Non-Linear data structures
- Students will be able to handle various operations like searching, insertion, deletion and traversals on various data structures.
- Students will be able to explain various data structures, related terminologies and its types.
- Students will be able to choose appropriate data structure and apply it to solve problems in various domains
- Students will be able to analyze and Implement appropriate searching techniques for a given problem.
- Students will be able to demonstrate the ability to analyze, design, apply and use data

structures to solve engineering problems and evaluate their solutions.

Subject: Digital Logic & Computer Architecture (Course Code- CSC 304)

- To learn different number systems and basic structure of computer system
- To demonstrate the arithmetic algorithms
- To understand the basic concepts of digital components and processor organization.
- To understand the generation of control signals of computer.
- To demonstrate the memory organization.
- To describe the concepts of parallel processing and different Buses.

Subject: Computer Graphics(Course Code- CSC 305)

- Describe the basic concepts of Computer Graphics
- Demonstrate various algorithms for basic graphics primitives.
- Apply 2-D geometric transformations on graphical objects.
- Use various Clipping algorithms on graphical objects
- Explore 3-D geometric transformations, curve representation techniques and projections methods.
- Explain visible surface detection techniques and Animation

Course Outcomes R- 2019 University of Mumbai
Syllabus (choice Based Credit Grading System)
SECOND YEAR Sem- IV (CBCS)

Subject: Engineering Mathematics IV(Course Code- CSC 401)
- Apply the concepts of eigenvalues and eigenvectors in engineering problems.
- Use the concepts of Complex Integration for evaluating integrals, computing residues &
- evaluate various contour integrals.
- Apply the concept of Z- transformation and inverse in engineering problems.
- Use the concept of probability distribution and sampling theory to engineering problems
- Apply the concept of Linear Programming Problems to optimization
- Solve Non-Linear Programming Problems for optimization of engineering problems.

Subject: Analysis of Algorithm(Course Code- CSC 402)
- Analyze the running time and space complexity of algorithms
- Describe, apply and analyze the complexity of divide and conquer strategy.
- Describe, apply and analyze the complexity of greedy strategy.
- Describe, apply and analyze the complexity of dynamic programming strategy.
- Explain and apply backtracking, branch and bound.
- Explain and apply string matching techniques.

Subject: Database Management System(Course Code- CSC 403)
- Recognize the need of database management system
- Design ER and EER diagram for real life applications
- Construct relational model and write relational algebra queries.

- Formulate SQL queries
- Apply the concept of normalization to relational database design
- Describe the concept of transaction, concurrency and recovery.

Subject: Operating System(Course Code- CSC 404)

- Understand the objectives, functions and structure of OS
- Analyze the concept of process management and evaluate performance of processscheduling algorithms.
- Understand and apply the concepts of synchronization and deadlocks
- Evaluate performance of Memory allocation and replacement policies
- Understand the concepts of file management.
- Apply concepts of I/O management and analyze techniques of disk scheduling.
  Module

Subject: Microprocessor(Course Code- CSC 405)

- Describe core concepts of 8086 microprocessor.Interpret the instructions of 8086 and write assembly and Mixed language programs.
- Identify the specifications of peripheral chip
- Design 8086 based system using memory and peripheral chips.
- Appraise the architecture of advanced processors
- Understand hyper threading technology

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Department of First Year Engineering
Course Outcomes R-2016 University of Mumbai Syllabus

(Choice Based Credit Grading System)

FE: SEMESTER I

SUBJECT	Applied Mathematics-I (FEC101)
CO1	Apply the concepts of complex numbers to the engineering problems.
CO2	Apply the knowledge of nth order derivatives of standard functions to engineering problems.
CO3	Apply the principles of basic operations of matrices to the engineering problems.
CO4	Apply the basic principles of partial differentiation to engineering problems.
CO5	Apply concepts of partial differentiation (maxima and minima, Jacobian), expansion of functions as an application of successive differentiation.
CO6	Apply SCILAB programming techniques to model problems based on solution of simultaneous linear algebraic equations.
SUBJECT	Applied Physics – I (FEC102)
CO1	Apply the concepts of crystallography and to use XRD techniques for analysis of crystal structure.
CO2	Apply the knowledge of Quantum mechanics to uncertainty principle and motion of free particle.
CO3	To comprehend the basic concepts of semiconductor physics and apply the same to electronic devices.
CO4	Apply the knowledge of superconductivity to SQUID and Magnetic levitation.
CO5	Apply the reasons for Acoustic defects and use this in the proper design of a Hall/Auditorium.
CO6	Use the knowledge of Piezoelectric and Magnetostriction effect for production of ultrasonic waves and its application in various fields.
SUBJECT	Applied Chemistry– I (FEC103)
CO1	Apply the knowledge of types of hardness of water and its estimation.
CO2	Apply the knowledge of various softening and disinfecting methods.
CO3	Apply the knowledge of various polymers, their synthesis, properties and uses along with their fabrication techniques.
CO4	Apply the knowledge of thermodynamics in studying different chemical systems in equilibrium obeying Gibb's phase rule.
CO5	Apply the knowledge of lubricants, types, properties and mechanisms to avoid frictional resistance.
CO6	Demonstrate the knowledge of Portland cement and carbon nanomaterials.
SUBJECT	Engineering Mechanics (FEC104)
CO1	Illustrate the concept of force, moment and apply the same along with the
CO2	Demonstrate the understanding of Centroid and its significance and locate the same.
CO3	Correlate real life application to specific type of friction and estimate required force to overcome friction.
CO4	Establish relation between velocity and acceleration of a particle and analyse the motion by plotting the relation
CO5	Illustrate different types of motions and establish Kinematic relations for a rigid body
CO6	Analyse body in motion using force and acceleration, work-energy, impulse-momentum principles

SUBJECT	Basic Electrical Engineering (FEC105)
CO1	To evaluate D.C. circuits using network theorems.
CO2	To evaluate 1-Φ AC circuits.
CO3	To illustrate constructional features and operation of 1-Φ transformer.
CO4	To evaluate 3-Φ AC circuits.
CO5	To illustrate working principle of DC machines.
CO6	To conduct experiments on D.C. circuits and AC circuits.
SUBJECT	Environmental Studies (FEC106)
CO1	Illustrate Depleting Nature of Environmental Resources, Global Environmental Crisis, Ecosystem concept.
CO2	Adapt to 3R (Reuse, Recovery, Recycle).
CO3	Study different control measures related to Environmental Pollution.
CO4	Illustrate and analyse various Case Studies related to Environmental Legislation.
CO5	Demonstrate the working of Renewable energy sources & Equipment's.
CO6	Illustrate the Techniques of Disaster Management and Green Building.

Course Outcomes R-2016 University of Mumbai Syllabus

(Choice Based Credit Grading System)

FE: SEMESTER II

SUBJECT	Applied Mathematics-II (FEC201)
CO1	Apply the concepts of First Order and first degree Differential equation to the engineering problems.
CO2	Apply the concepts of Higher Order Linear
CO3	Apply concepts of Beta and Gamma function to the engineering Problems.
CO4	Apply SCILAB programming techniques to solve differential equation to model complex engineering activities.
CO5	Apply concepts of Double integral of different coordinate systems to the engineering problems.
CO6	Apply concepts of triple integral of different coordinate systems to the engineering problems.
SUBJECT	Applied Physics – II (FEC202)
CO1	Comprehend principles of interference and diffraction.
CO2	Illustrate the principle, construction and working of various LASERs and its applications.
CO3	Identify various applications of optical fibres.
CO4	Comprehend the concepts of electrodynamics and Maxwell's equations and their use in telecommunication systems.
CO5	Apply the concepts of electromagnetism in focusing systems and CRO.
CO6	Comprehend the significance of nanoscience and nanotechnology, its applications.
SUBJECT	Applied Chemistry – II (FEC203)
CO1	Identify types of corrosion and factors affecting it related to problems affecting all industries.

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CO2	Identify different types of corrosion control methods to study corrosion control in various industries.
CO3	Apply the knowledge of different types of fuels, including their production and refining methods and combustion mechanisms.
CO4	Illustrate composition and properties of different types of alloys and the process of powder metallurgy
CO5	Illustrate principals of green chemistry.
CO6	Illustrate properties and applications of different types of composite materials.
SUBJECT	**Engineering Drawing (FEC204)**
CO1	Apply the basic principles of projections in 2D drawings.
CO2	Apply the basic principles of projections in converting 3D view to 2D drawing.
CO3	Read a given drawing.
CO4	Visualize an object from the given two views.
CO5	Use CAD tool to draw different views of a 3D object.
CO6	Use CAD tool to draw an object in 3D.
SUBJECT	**Structured Programming Approach (FEC205)**
CO1	Illustrate the basic terminology used in computer programming.
CO2	Illustrate the concept of data types, variables and operators using C.
CO3	Design and Implement control statements and looping constructs in C.
CO4	Apply function concept on problem statements.
CO5	Demonstrate the use of arrays, strings, structures and files handling in C.
CO6	Demonstrate the dynamics of memory by the use of pointers to construct various data structures.
SUBJECT	**Communication Skills (FEC206)**
CO1	Understand and evaluate information they listen to and express their ideas with greater clarity
CO2	Speak and respond effectively along the various channels of communication in a business organization
CO3	Speak convincingly before an audience with the help of an expanded vocabulary and enhanced digital content
CO4	Read and summarize effectively
CO5	Communicate through result oriented writing both within and outside the organization.
CO6	Write a set of effective and easy to understand technical description, instructions and convey the same using global information technology

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Course Outcomes R-2019 University of Mumbai Syllabus

(C SCHEME)

FE: SEMESTER I

SUBJECT	Engineering Mathematics-I (FEC101)
CO1	Apply the basic concepts of Complex Numbers and will be able to use it for engineering problems.
CO2	Apply hyperbolic functions and logarithms in the subjects like electrical circuits, Electromagnetic wave theory.
CO3	Apply the basic concepts of partial differentiation of function of several variables and will be able to use in subjects like Electromagnetic Theory, Heat and Mass Transfer etc.
CO4	Apply the concept of Maxima, Minima and Successive differentiation and will be able to use it for optimization and tuning the systems.
CO5	Apply the concept of Matrices and will be able to use it for solving the KVL and KCL in electrical networks.
CO6	Apply the concept of Numerical Methods for solving the engineering problems with the help of SCILAB software.
SUBJECT	Engineering Physics-I (FEC102)
CO1	Illustrate the fundamentals of quantum mechanics and its application.
CO2	Explain peculiar properties of crystal structure and apply them in crystallography using X-ray diffraction techniques.
CO3	Comprehend the concepts of semiconductor physics and applications of semiconductors in electronic devices.
CO4	Employ the concept of interference in thin films in measurements.
CO5	Discuss the properties of Superconductors and Super capacitors to apply them in novel applications.
CO6	Compare the properties of engineering materials for their current and futuristic frontier applications.
SUBJECT	Engineering Chemistry-I (FEC103)
CO1	Explain the concept of microscopic chemistry in terms of atomic and molecular orbital theory and relate it to diatomic molecules.
CO2	Describe the concept of aromaticity and interpret it with relation to specific aromatic systems.
CO3	Illustrate the knowledge of various types of intermolecular forces and relate it to real gases.
CO4	Interpret various phase transformations using thermodynamics.
CO5	Illustrate the knowledge of polymers, fabrication methods, conducting polymers in various industrial fields.
CO6	Analyse the quality of water and suggest suitable methods of treatment.
SUBJECT	Engineering Mechanics (FEC104)
CO1	Illustrate the concept of force, moment and apply the same along with the concept
CO2	Demonstrate the understanding of Centroid and its significance and locate the same.
CO3	Correlate real life application to specific type of friction and estimate required force to overcome friction.
CO4	Establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation
CO5	Illustrate different types of motions and establish Kinematic relations for a rigid body

CO6	Analyse particles in motion using force and acceleration, work-energy and impulse-momentum principles
SUBJECT	**Basic Electrical Engineering (FEC105)**
CO1	Apply various network theorems to determine the circuit response / behavior.
CO2	Evaluate and analyse 1-Φ circuits.
CO3	Evaluate and analyse 3-Φ AC circuits.
CO4	Understand the constructional features and operation of 1-Φ transformer.
CO5	Illustrate the working principle of 3-Φ machine.
CO6	Illustrate the working principle of 1-Φ machines.

Course Outcomes R-2019 University of Mumbai Syllabus

(C SCHEME)

FE: SEMESTER II

SUBJECT	**Engineering Mathematics-II (FEC201)**
CO1	Apply the concepts of First Order and first degree Differential equation to the problems in the field of engineering.
CO2	Apply the concepts of Higher Order Linear Differential equation to the engineering problems.
CO3	Apply concepts of Beta and Gamma function to solve improper integrals.
CO4	Apply concepts of Double integral of different coordinate systems to the engineering problems like area and mass.
CO5	Apply concepts of triple integral of different coordinate systems to the engineering problems and problems based on volume of solids.
CO6	Solve differential equations and integrations numerically using SCILAB software to experimental aspect of applied mathematics.
SUBJECT	**Engineering Physics-II (FEC202)**
CO1	Describe the diffraction through slits and its applications.
CO2	Apply the foundation of laser and fiber optics in development of modern communication technology.
CO3	Relate the basics of electrodynamics which is prerequisite for satellite communications, antenna theory etc.
CO4	Explain the fundamentals of relativity.
CO5	Assimilate the wide scope of nanotechnology in modern developments and its role in emerging innovating applications.
CO6	Interpret and explore basic sensing techniques for physical measurements in modern instrumentations.
SUBJECT	**Engineering Chemistry-II (FEC203)**
CO1	Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.

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CO2	Illustrate the concept of emission spectroscopy and describe the phenomena of fluorescence and phosphorescence in relation to it.
CO3	Explain the concept of electrode potential and Nernst theory and relate it to electrochemical cells.
CO4	Identify different types of corrosion and suggest control measures in industries.
CO5	Illustrate the principles of green chemistry and study environmental impact.
CO6	Explain the knowledge of determining the quality of fuel and quantify the oxygen required for combustion of fuel.
SUBJECT	**Engineering Graphics (FEC204)**
CO1	Apply the basic principles of projections in Projection of Lines and Planes
CO2	Apply the basic principles of projections in Projection of Solids.
CO3	Apply the basic principles of sectional views in Section of solids.
CO4	Apply the basic principles of projections in converting 3D view to 2D drawing.
CO5	Read a given drawing.
CO6	Visualize an object from the given two views.
SUBJECT	**C Programming (FEC205)**
CO1	Formulate simple algorithms for arithmetic, logical problems and translate them to programs in C language
CO2	Implement, test and execute programs comprising of control structures.
CO3	Decompose a problem into functions and synthesize a complete program.
CO4	Demonstrate the use of arrays, strings and structures in C language.
CO5	Understand the concept of pointers
CO6	Formulate simple algorithms for arithmetic, logical problems and translate them to programs in C language
SUBJECT	**Professional Communication and Ethics- I (FEC206)**
CO1	Eliminate barriers and use verbal/non-verbal cues at social and workplace situations.
CO2	Employ listening strategies to comprehend wide-ranging vocabulary, grammatical structures, tone and pronunciation.
CO3	Prepare effectively for speaking at social, academic and business situations.
CO4	Use reading strategies for faster comprehension, summarization and evaluation of texts.
CO5	Acquire effective writing skills for drafting academic, business and technical documents.
CO6	Successfully interact in all kinds of settings, displaying refined grooming and social skills.

Course Outcomes R-2019 University of Mumbai Syllabus

(C SCHEME)

FE: SEMESTER I

SUBJECT	**Engineering Physics-I (FEL101)**
CO1	Perform the experiments based on interference in thin films and analyze the results.
CO2	Verify the theory learned in the module crystallography.

CO3	Perform the experiments on various semiconductor devices and analyze their characteristics.
CO4	Perform simulation study on engineering materials.
SUBJECT	**Engineering Chemistry-I (FEL102)**
CO1	Determine Chloride content and hardness of water sample
CO2	Determine free acid ph of different solutions
CO3	Determine metal ion concentration
CO4	Synthesize polymers, biodegradable plastics.
CO5	Determine Viscosity of oil
SUBJECT	**Engineering Mechanics (FEL103)**
CO1	Verify equations of equilibrium of coplanar force system
CO2	Verify law of moments.
CO3	Determine the centroid of plane lamina.
CO4	Evaluate co-efficient of friction between the different surfaces in contact.
CO5	Demonstrate the types of collision/impact and determine corresponding coefficient of restitution.
CO6	Differentiate the kinematics and kinetics of a particle.
SUBJECT	**Basic Electrical Engineering (FEL104)**
CO1	Interpret and analyse the behaviour of DC circuits using network theorems.
CO2	Perform and infer experiment on single phase AC circuits.
CO3	Demonstrate experiment on three phase AC circuits.
CO4	Illustrate the performance of single phase transformer and machines.
SUBJECT	**Basic Workshop Practice-I (FEL105)**
CO1	Develop the necessary skill required to handle/use different fitting tools.
CO2	Develop skill required for hardware maintenance.
CO3	Able to install an operating system and system drives.
CO4	Able to identify the network components and perform basic networking and crimping.
CO5	Able to prepare the edges of jobs and do simple arc welding.
CO6	Develop the necessary skill required to handle/use different plumping tools.
CO7	Demonstrate the turning operation with the help of a simple job.

Course Outcomes R-2019 University of Mumbai Syllabus

(C SCHEME)

FE: SEMESTER II

SUBJECT	**Engineering Physics-II (FEL201)**
CO1	Perform the experiments based on diffraction through slits using Laser source and analyze the results.

CO2	Perform the experiments using optical fibre to measure numerical aperture of a given fibre.
CO3	Perform the experiments on various sensors and analyze the result.
SUBJECT	**Engineering Chemistry-II (FEL202)**
CO1	Determine moisture and ash content of coal
CO2	Analyse flue gas
CO3	Determine saponification and acid value of oil
CO4	Determine flash point of a lubricating oil
CO5	Synthesize a drug and a biofuel.
CO6	Determine na/k and emf of cu-zn system
SUBJECT	**Engineering Graphics (FEL203)**
CO1	Apply the basic principles of projections in 2D drawings using a CAD software.
CO2	Create, Annotate, Edit and Plot drawings using basic AutoCAD commands and features.
CO3	Apply the concepts of layers to create drawing.
CO4	Apply basic AutoCAD skills to draw different views of a 3D object.
CO5	Apply basic AutoCAD skills to draw the isometric view from the given two views.
SUBJECT	**C Programming (FEL204)**
CO1	Translate given algorithms to a program.
CO2	Correct syntax and logical errors.
CO3	Write iterative as well as recursive programs.
CO4	Represent data in arrays, strings and structures and manipulate them through a program.
CO5	Declare pointers and demonstrate call by reference concept.
SUBJECT	**Professional Communication and Ethics- I (FEL205)**
CO1	Listen and comprehend all types of spoken discourse successfully.
CO2	Speak fluently and make effective professional presentations.
CO3	Read large quantities of text in a short time to comprehend, summarise and evaluate content.
CO4	Draft precise business letters, academic essays and technical guidelines.
CO5	Dress finely and conduct themselves with panache in social, academic and professional situations
SUBJECT	**Basic Workshop Practice-II (FEL206)**
CO1	Develop the necessary skill required to handle/use different carpentry tools.
CO2	Identify and understand the safe practices to adopt in electrical environment.
CO3	Demonstrate the wiring practices for the connection of simple electrical load/ equipment.
CO4	Design, fabricate and assemble pcb.
CO5	Develop the necessary skill required to handle/use different masons tools.
CO6	Develop the necessary skill required to use different sheet metal and brazing tools.
CO7	Able to demonstrate the operation, forging with the help of a simple job.